THE
ANATOMY
OF THE
Human Nerves,

WITH

An Account of the reciprocal Motions of the HEART,

AND

A Deſcription of the HUMAN LACTEAL SAC and DUCT.

By ALEXANDER MONRO, *P. A.*

EDINBURGH,

Printed for Mr. W. MONRO and W. DRUMMOND.
Sold by them and other Bookſellers there.

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PREFACE.

THE *firſt Sketch of the following Eſſays was wrote for the Service of a Friend, without any Intention of mine to have been an Author. When they were publiſhed, I was glad of the Opportunity which the ſecond Edition of the Anatomy of the Bones gave me to correct them, and I thought Mr.* Winſlow's *Anatomy made any further Labour of mine on theſe Subjects unneceſſary. But whenever it was foreſeen that this third Edition of the Oſteology was to be printed, I was teazed with the Importunities of Friends and Scholars, to make the Anatomy of the Nerves more complete, and to tack the other two Eſſays to it. It was in vain for me to plead the Difficulty, if not Impoſſibility of bringing the Phyſiology of the Nerves to any Certainty, tho' it might engage me in an endleſs Diſpute; and that any other Deſcription of the Diſtribution of the Nerves, than what Mr.* Winſlow *had given, was altogether ſuperfluous: They inſiſted, would not be refuſed, and forced me to undertake it.*

In the Account of the Nerves in general, I have avoided what I could to give Offence; and therefore have not only treated all the Opinions I mention with that Modeſty which the Uncertainty of the Subject re-

quired, but have not named one Author, flattering myſelf, that thoſe, whom I was under the Neceſſity to redargue, might be better concealed by my not declaring whom I approved.

I attempted an accurate Deſcription of the particular Nerves; but upon comparing the Notes I wrote of what I ſaw in diſſecting the Nerves with Mr. Winſlow's Expoſition des Nerfs, *I found I had done little more than uſed other Words for deſcribing the ſame Things; and upon giving my Papers to be peruſed by ſome of thoſe for whoſe Uſe any Thing I write is chiefly intended, I mean the Students in Phyſick, I diſcovered another Misfortune ſufficient to make me alter my Deſign. The young Anatomiſts were ſo confounded with the Variety of Branches and their Sub-diviſions, that they could not ſee even the groſs Outlines of the Picture I had attempted to draw. That I might be underſtood, and my Scholars might thereby be aſſiſted to remember the more minute Diſſections I ſhou'd ſhew them, I changed my Notes into a ſuperficial Deſcription of the larger Branches of the Nerves.*

The Account of the Syſtole *and* Diaſtole *of the Heart is the immortal* Boerhaave's *Doctrine illuſtrated, and the Deſcription of the* Receptaculum Chyli, *and of the* Ductus Thoracicus *is nearly the ſame as it was in the former Edition.*

THE ANATOMY OF THE *Human Nerves.*

Of the Nerves in general.

1. BY the Aſſiſtance of Injections and Microſcopes wonderful Plexuſes of Blood-veſſels are diſcovered to go from the *Pia Mater* into the *Cortex*, cineritious, or aſhy-coloured Part of the *Cerebrum*, *Cerebellum* and *ſpinal Marrow*, whereas we can only ſee longitudinal Veſſels, without numerous Ramifications or reticular Plexuſes, in the white medullary Subſtance of theſe Parts.

2. The Continuity of the *Cortex* with the *Medulla* of the *Encephalon* and *ſpinal Marrow* is obſervable with the naked Eye, and is more diſtinctly ſeen with the Aſſiſtance of a Microſcope.

3. In diſſecting the *Brain* and *Cerebellum*, we ſee the ſmall Beginnings of the *Medulla* proceeding from the *Cortex*, and can trace its gradual Increaſe by the Addition of more *Medulla* coming from the *Cortex*.

4. Both *Cortex* and *Medulla* are very ſucculent; for being expoſed to the Air to dry, they loſe more of their Weight than moſt other Parts of the Body do.

5. In ſeveral Places we can obſerve the *Medulla* to be compoſed of Fibres laid at each other's Sides.

6. The medullary Subſtance is all employed in forming the white fibrous Cords, which have now the Name of *Nerves* appropriated to them. Within the Skull we ſee the Nerves to be the medullary ſubſtance continued, and the *medulla ſpinalis* is all employed in forming Nerves.

7. The common Opinion concerning the Riſe of the Nerves, founded on a ſuperficial Inſpection of thoſe Parts, is, that the Nerves are propagated from the ſame Side of the *Encephalon* at which they go out. But it having been remarked, after a more ſtrict Enquiry, and preparing the Parts by Maceration in Water, that the medullary Fibres decuſſate or croſs each other in ſome Parts of the *Medulla*; as for Example, at the *Corpus annulare*, and Beginning of the *Medulla ſpinalis*: And practical Obſervators having related ſeveral Examples of People, whoſe Brain was hurt on one Side, while the morbid Symptom, Palſy, appeared on the other Side of the Body, of which I have ſeen two Inſtances; and Experiments made on Brutes having confirmed theſe

Obſervations, it has been thought, that the Nerves had their Riſe from the Side of the *Encephalon*, oppoſite to their Egreſs from the Skull. It may however ſtill be ſaid, that this laſt Opinion is not fully demonſtrated, becauſe a Decuſſation in ſome few Parts is not a Proof that it obtains univerſally; and if there are Examples of Palſy of the Side oppoſite to where the Leſion of the Brain was, there are alſo others, where the Injury done to the Brain and the Palſy were both on the ſame Side.

8. The Nerves are compoſed of a great many Threads lying parallel, where they come out from the *Medulla*.

This fibrous Texture is evident at the Origin of moſt of the Nerves within the Skull, and in the *Cauda equina* of the *Medulla ſpinalis*, we can divide them into ſuch ſmall Threads, that a very quick-ſighted Eye can ſcarce perceive them; but theſe Threads, when looked at with a Microſcope, appear each to be compoſed of a great Number of ſmaller Threads.

9. How ſmall one of theſe Fibrils of the Nerves is we know not, but when we conſider that every, even the moſt minute Part of the Body is ſenſible, and that this muſt depend on the Nerves (which all conjoined would not make a Cord of an Inch Diameter) being divided into Branches or Filaments to be diſperſed through all theſe minute Parts, we muſt be convinced that the nervous Fibrils are very ſmall. From the Examination of the *minimum viſibile* it is demonſtrated, that each Fibre in the *Retina* of the Eye, or expanded optick Nerve, cannot exceed the Size of the 32400 Part of a Hair.

10. The medullary Subſtance, of which the nervous Fibrils are compoſed, is very tender, and would not be able to reſiſt the common Force of the circulating Fluids, and other ſuch Forces to which the Nerves are expoſed within the Bones, were not the *Pia Mater* and *Tunica Arachnoides* continued upon them. The former giving them Firmneſs and Strength, and the latter furniſhing a cellular Coat to connect the Threads of the Nerves, to let them ly ſoft and moiſt, and to ſupport the Veſſels which go with them.

It is this cellular Subſtance that is diſtended with Air when it is blown through a Blowpipe thruſt into a Nerve, and that makes a Nerve appear all ſpungy, after being diſtended with Air till it dries, the proper nervous Fibrils ſhriveling ſo in drying as they ſcarce can be obſerved.

11. Theſe Coats, § 10. would not make the Nerves ſtrong enough to bear the ſtretching and Preſſure they are expoſed to in their Courſe to the different Parts of the Body; and therefore as the Nerves are going out at the Holes in the *Cranium* and *Spine*, the *Dura Mater* is cloſely wrapt round them, to collect their diſgregated Fibres into tenſe firm Cords, and that the ſtretching they may be expoſed to may have no Effect to hurt them where they are not ſtrengthned thus by the *Dura Mater*; this ſtrong Membrane is firmly fixed to the Sides of the Holes in the Bones through which they paſs.

12. The nervous Cords thus compoſed of nervous Fibrils, cellular Coat, *Pia* and *Dura Mater*, have ſuch numerous Blood-veſſels beſtowed on them, that after their Arteries only

are injected, the whole Cord can be tinged of the Colour of the injected Liquor; and if the Injection is puſhed too violently, the cellular Subſtance of the Nerves comes to be diſtended with it.

13. A nervous Cord, ſuch as has been juſt now deſcribed, § 12. has very little Elaſticity, compared with other Parts of the Body. When cut out of the Body, it does not become obſervably ſhorter, while the Blood-veſſels contract three Eighths of their Length.

14. In the Courſe which the Nerves have to the ſeveral Parts of the Body, they are generally lodged in a cellular or fatty ſubſtance, and run in the Interſtices of the Muſcles and other active Organs, that ſo they might be little expoſed to the Preſſure which theſe Parts would make upon them, and might be defended from any bad Effects which ſuch Preſſure might otherwiſe produce.

15. The larger Cords of the Nerves divide into Branches in their Diſtribution to the different Parts; the Branches being ſmaller than the Trunk from which they come, and making generally an acute angle where they ſeparate.

16. In ſeveral Places different Nerves unite into one Cord, which is commonly larger than any of the Nerves which form it.

17. Several Nerves, particularly thoſe which are diſtributed to the Bowels, ſuddenly form a hard Knot, conſiderably larger than all the Nerves of which it is made. Theſe Knots were called *Corpora olivaria*, and are now generally named *Ganglions*.

18. The *Ganglions* have much thicker Coats and larger, more numerous Blood-veſſels than

the Nerves, ſo that they appear redder and more muſcular. On diſſecting the *Ganglions*, Fibres are ſeen running longitudinally in their Axes, and other Fibres are derived from their Sides in an oblique direction to the longitudinal ones.

19. The Nerves which go out from the *Ganglions* are no way remarkably different from other Nerves.

20. The Nerves that are ſent to our Organs of the Senſes loſe there their firm Coats, and terminate in a pulpy Subſtance. The *optick Nerves* are expanded into the ſoft tender Webs the *Retinæ*; the *auditory Nerve* has ſcarce the Conſiſtence of *Mucus* in the *Veſtibulum*, *Cochlea* and *ſemicircular Canals* of each Ear; the *Papillæ* of the Noſe, Tongue and Skin are very ſoft.

21. The Nerves of Muſcles can likewiſe be traced till they loſe their Coats and become very ſoft, from which, and what we obſerved of the ſenſatory Nerves, § 20. there is Reaſon to conclude, that the muſcular Nerves are alſo pulpy at their Terminations, which we cannot indeed proſecute by Diſſection.

22. It would ſeem neceſſary that the Extremities of the Nerves ſhould continue in this ſoft flexible State, (§ 20, 21.) in order to perform their Functions right: For in proportion as Parts become rigid and firm by Age, or any other Cauſe, they loſe of their Senſibility, and the Motions are more difficultly performed.

23. Tho' the Fibres in a nervous Cord are firmly connected, and frequently different Nerves join into one Trunk, or into the ſame *Ganglion*, yet the Senſation of each Part of the

Body is ſo very diſtinct; and we have ſo much the Power of moving the Muſcles ſeparately, that, if the Nerves are principal Agents in theſe two Functions, which I ſhall endeavour to prove they are, we have Reaſon to believe that there is no Union, Confuſion or immediate Communication of the proper nervous Fibrils, but that each Fibre remains diſtinct from its Origin to its Termination.

24. Changes produced any way upon the Coats of the Nerves cannot however miſs to affect the nervous Fibrils. The cellular Subſtance may be too full of Liquor or may not ſupply enough; the Liquor may not be of a due Conſiſtence, or it may be preternaturally obſtructed and collected. The *Pia Mater* may be too tenſe or too lax, as may alſo the *Dura Mater*; their Veſſels may be obſtructed; their proper Nerves may be violently irritated or loſe their Power of acting; and a great many other ſuch Changes may happen which will not only occaſion Diſorders in particular Nerves, but may cauſe the *Sympathy* ſo frequently obſerved among the Nerves, which is ſo neceſſary to be attentively regarded in a great many Diſeaſes in order to diſcover their true State and Nature, without the Knowledge of which we muſt commit very dangerous Miſtakes in the Practice of Phyſick and Surgery.

25. Many Experiments and Obſervations concur in proving, that when Nerves are compreſſed, cut, or any other way deſtroyed, the Parts ſerved by ſuch Nerves farther from the Head or Spine than where the injuring Cauſe has been applied have their Senſations, Motions and Nouriſhment weakned or loſt, while on

no ſuch Effects are ſeen in the Parts nearer to the Origins of thoſe Nerves; and in ſuch Experiments where the Cauſe impeding the Nerves to exert themſelves could be removed, and the Structure of the Nerves not injured; as for Example, when a Ligature made upon a Nerve and ſtopping its Influence has been taken away, the Motion and Senſation of the Parts ſoon were reſtored. From which it would appear that the Nerves are principal Inſtruments in our Senſations, Motions and Nouriſhment; and that this Influence of the Nerves is not inherent in them without the Communication between theſe Cords, and their Origin is preſerved.

It will be no Objection to this Concluſion, that ſometimes, upon cutting a Nerve, the Effects above-mentioned have been felt for a ſhort Time, but afterwards the Perſon was ſenſible of no Numneſs or Immobility; for wherever this is ſaid to have happened, the cut Nerve was only one of ſeveral which were ſent to the Member, the want of whoſe Influence would be felt no longer than till the Habit was acquired of performing the Functions eaſily by the other Nerves.

It is of no greater Weight as an Objection, that when a Ligature is drawn very hard upon a Nerve, the Nerve never again recovers its Influence upon the Parts it is diſtributed to beyond the Ligature, but is of as little Effect as if it had been cut thro'; which is to ſay, that its Texture has been alter'd beyond Recovery. The ſame Thing is to be ſeen by tying a Thread tight round a tender Twig of any vegetable, it decays.

26. Experiments and Obſervations ſhew too, that when Parts of the *Encephalon* or *Medulla ſpinalis* have been irritated, compreſſed or deſtroyed, the Parts of the Body, whoſe Nerves had their Origin from ſuch affected Parts of the *Encephalon* or *Medulla ſpinalis*, became convulſed, paralytick, inſenſible or waſted; and in ſuch Caſes where the injuring Cauſe could be removed from the Origin of the Nerves, the morbid Symptoms obſerved in the Parts to which theſe Nerves were diſtributed, went off upon the Removal of that Cauſe. From which it is thought reaſonable to conclude, that the Nerves muſt not only have a Communication with their Origin, but that the Influence they have upon the Parts they are diſtributed to, depends on the Influence which they derive from the *Medulla Encephali* and *ſpinalis*.

27. Tho' the *Medulla ſpinalis* has its own Veſſels and cineritious Subſtance which aſſiſts to form its *Medulla*, yet a very large Share of the Medullary Subſtance within the Spine is derived from the *Encephalon*, whoſe *Medulla oblongata* deſcends from the Head, and the Influence of the *Medulla ſpinallis* on its Nerves depends in a great Meaſure on this *Medulla oblongata* of the Head. Hence an Injury done to any Part of the *Medulla ſpinalis* immediately affects all the Parts whoſe Nerves have their Origin below where the injuring Cauſe is applied to the Spinal Marrow. A Luxation of a *Vertebra* in the Loins makes the lower Extremities ſoon paralytick; a tranſverſe Section of the *Medulla* at the firſt *Vertebra* of the Neck ſoon puts an End to Life.

28. If ſuch Cauſes produce conſtantly ſuch Effects (§ 25, 26, 27,) in us and other Creatures living in nearly the ſame Circumſtances as we do, the Concluſions already made will be good, notwithſtanding Examples of Children and other Creatures being born without *Brains* or *Medulla ſpinalis*; or notwithſtanding the Brains of adult Creatures being much changed in their Texture by Diſeaſes, and notwithſtanding the Experiments of cutting off the Heads of *Tortoiſes*, and ſome other Animals which continued to move about a conſiderable Time after their Heads were off. We may be ignorant of the particular Circumſtances requiſite or neceſſary to the Being or Wellbeing of this or that particular Creature, and we may be unable to account for a great many Phænomena; but we muſt believe our Eyes in the Examination of Facts, and if we ſee conſtantly ſuch Conſequences from ſuch Actions, we cannot but conclude the one to be the Cauſe, and the other the Effect. It would be as unjuſt to deny the Concluſions made in the three preceeding Articles, becauſe of the ſeemingly preternatural Phænomena mentioned in the Beginning of this, as it would be to deny the Neceſſity of the Circulation of the Blood in us and Quadrupeds, becauſe a Frog can jump about or a Tortoiſe can walk long after all the Bowels of its Thorax and Abdomen are taken out, or becauſe the different Parts of a Worm crawl after it has heen cut into a great many Pieces. It is therefore almoſt univerſally agreed that the Nerves are principal Inſtruments in our Senſations, Motion and Nouriſhment, and

that the Influence which they have is communicated from their Origin, the *Encephalon* and *Medulla ſpinallis*; but Authors are far from agreeing about the Manner in which this Influence is communicated, or in what Way Nerves act to produce theſe Effects.

29. Some alledge that *the nervous Fibres are all ſolid Cords acting by Elaſticity or Vibration.* Others affirm that *thoſe Fibres are ſmall Pipes conveying Liquors, by means of which all their Effects are produced.*

30. The Gentlemen, who think the nervous Fibres ſolid, raiſe ſeveral Objections to the other Doctrine, which I ſhall conſider afterwards, and endeavour to ſhew the Fitneſs of their own Doctrine to account for the Effects commonly obſerved to be produced by the Nerves.

The Objects of the Senſes plainly, ſay they, make Impulſes on the Nerves of the proper Organs, which muſt ſhake the nervous Fibrils, and this Vibration muſt be propagated along the whole Cord to its other Extremity or Origin, as happens in other tenſe Strings; and theſe Vibrations being differently modified according to the Difference of the Object, and its different Application, produce the different Ideas we have of Objects.

31. To this Account of the Senſations it is objected, 1*ſt*, That Nerves are unfit for Vibrations, becauſe their Extremities, where Objects are applied to them, are quite ſoft and pappy, (§ 20.) and not ſuſceptible of the Vibrations ſuppoſed; and if there could be any little Tremor made here by the Impulſe of Objects, it could not be continued along the ner-

vous Cord, becauſe the cellular Subſtance by which each particular Fibre is connected to the neighbouring ones, (§ 10.) and the fatty Subſtance in which the nervous Cord is immerſed (§ 14) would ſoon ſtifle any ſuch vibratory Motion.

The 2*d* Objection to this Doctrine is, that, ſuppoſing the Nerves capable of Vibrations by the Impreſſions of Objects, theſe Vibrations would not anſwer the Deſign. For if what we know of other vibrating Strings, to wit, that their Tone remains the ſame, unleſs their Texture, Length or Tenſion is altered, and that different Subſtances ſtriking them do no more than make the Sound higher or lower: If theſe Properties are to be applied to Nerves, then it will follow that the ſame Nerve would conſtantly convey the ſame Idea, with no other Variety than of its being weaker or ſtronger, whatever different Objects were applied to it, unleſs we ſuppoſe the Nerve changed in its Texture, Length or Tenſion each Time a different Object is applied, which, it is preſumed, no Body will undertake to prove does happen. But further, if ever ſuch a Variety of Vibrations could be made, our Senſations would notwithſtanding be confuſed and indiſtinct, becauſe the tremulous nervous Fibre being firmly connected, and contiguous to ſeveral other Fibres of the ſame Cord, would neceſſarily ſhake them too, by which we ſhould have the Notion of the Object as applied at all the different Parts where the Extremities of theſe Fibres terminate.

32. In whatever way the Favourers of the Doctrine of ſolid Nerves pleaſe to apply the

Elaſticity of Nerves to the Contraction of Muſcles; their Adverſaries inſiſt that Nerves are too weak to reſiſt ſuch Weights as the Muſcles ſuſtain, they would ſurely break, eſpecially that they are greatly, if not wholly, deprived of their ſtrong Coats before they come to the Part of the Muſcle, they are immediately to act upon (§ 21.) and the Nerves being found to have little or no Elaſticity to ſhorten themſelves (§ 12.) ſhews them altogether unfit for ſuch an Office as this of contracting Muſcles in the way propoſed of their acting by Elaſticity.

33. As a further Objection againſt either Motion or Senſation being owing to the Elaſticity of the Nerves, it is ſaid, that if this Doctrine was true, the Senſations would be more acute, and the Contractions of Muſcles would be greater and ſtronger, when the Parts become firmer and more rigid by Age; for then their Elaſticity is increaſed: Whereas on the contrary it appears, (§ 22.) that then the Senſations are blunted, and muſcular Contraction becomes leſs and weaker.

34. If the Nerves were granted to be elaſtic, and to communicate a ſpringy Force to all the Parts they are diſtributed to, they might appear neceſſary in this View to aſſiſt the Application of the nutritious Particles of the Fluids to the Sides of the Veſſels theſe Particles were to repair; and ſo far might well enough account for the Share Nerves are thought to have in Nutrition; yet if we cannot make uſe of Elaſticity in the other two Functions of Senſation and Motion, we muſt alſo endeavour to find out ſome other Way the

Nerves act in Nutrition, which will be done afterwards.

35. Having thus ſtated the Reaſons for and againſt the Nerves acting as ſolid Strings, let us likewiſe relate the Arguments for Nerves being Pipes, and the Objections to this Doctrine.

A great Argument of thoſe who think the Nerves to be Tubes conveying Liquors, is the ſtrong Analogy of the Brain and Nerves to other Glands of the Body and their Excretories, where a manifeſt Secretion of Liquor is made in the Glands to be conveyed by the Excretories, to the proper Places in which it ought to be depoſited: They think that the vaſcular Texture of the Cortex of the *Encephalon* and *Medulla ſpinalis* (§ 1.); the Continuation of the Cortex in forming the medullary Subſtance (§ 2. 3.), the fibrous Texture (§ 5.) and ſucculent State of this *Medulla* (§ 4.), and its being wholly employed to form the Nerves (§ 6.), where the fibrous Texture is evident (§ 8.); all theſe Things, ſay they, conſpire to ſhew ſuch a ſtrong Analogy between theſe Parts and the other Glands of the Body, as carries a Conviction that there is a Liquor ſecreted in the *Encephalon* and *Medulla ſpinalis*, to be ſent out by the Nerves to the different Parts of the Body.

36. The following Objections are raiſed to this Argument in favour of a Liquor conveyed in the Nerves, from the Analogy of the Glands. 1*ſt*, Other Glands, it is ſaid, have their Excretories collected into a few large Pipes, and not continued in ſuch a great Number of ſeparate Pipes, as far as the Places

where the Liquors are depoſited, which laſt muſt be the Caſe, if the Nerves are the Excretories of the glandular Brain. 2*dly*, We ſee the Cavities and can examine the Liquors in the Excretories of other Glands much ſmaller than the Brain, which cannot be done in the Nerves. 3*dly*, If the Nerves were Pipes, they would be ſo ſmall that the Attraction of their Sides to their Liquors would be ſo great, that the Liquors could not be moved with the Celerity required to influence our Senſations and Motions, in the quick Manner we ſee them performed. 4*thly*, If the Nerves were Pipes they would be cylindrical ones, and conſequently not ſubject to Diſeaſes, or at leaſt we could have no Comprehenſion of the Diſeaſes in them.

37. The Anſwer to the 1*ſt* of theſe Objections is, That there are other Glands where there is a manifeſt Secretion, and in which the Diſpoſition of the Excretories is in much the ſame way as in the *Encephalon*; the Kidneys, for Example, have a reticulated Cortex of Veſſels, from which the *Euſtachian* or *Bellinian Medulla*, conſiſting of longitudinal Fibres and a few longitudinal Blood Veſſels, proceeds; and this *Medulla* is collected into ten or twelve *Papillæ*, each of which is formed of numerous ſmall ſeparate Pipes, which ſingly diſcharge the Urine into the large membranous Tubes, which united compoſe the *Pelvis*. Upon comparing this Texture of the Kidney with what was ſaid of the *Encephalon*, (§ 1, 2, 3, 4, 5, 6, 8.) the Analogy will be found very ſtrong.

38. In Anſwer to the 2*d* Objection in § 36.

it is granted, that Microſcopes, Injections, and all the other Arts hitherto employed have not ſhewn the Cavities of the nervous Fibrils, or the Liquors contained in them; and from what was ſaid (§ 9.) of the ſmallneſs of the nervous Fibrils, it is not to be expected that ever they ſhould be ſeen. But ſo long as ſuch a Number of little Animals can every Hour be brought to the Framers of this Objection, in which they can as little demonſtrate the Veſſels or contained Fluids, it will not be allowed to be concluſive Reaſoning, that becauſe ocular Demonſtration cannot be given of Pipes, therefore they do not exiſt. For if we have any Notion of an Animal, it is its being a Hydraulick Machine, which has Liquors moving in it as long as it has Life; if therefore ſuch little Animals have Veſſels and Liquors which we cannot ſee, why may not ſome of the Veſſels and Liquors of the human Body be alſo inviſible to us.

To avoid this Anſwer to the Objection, it is further urged that tho' we might not ſee the Canals and Liquors of Nerves as they are flowing naturally, yet they ought to diſcover themſelves by the Canals being ſtretched, or a Nerve's ſwelling upon being firmly tied; and it might likewiſe be expected, that however ſubtile the Liquor of the Nerves is, it might be collected in ſome Drops at leaſt, when the cut End of a Nerve of a living Animal is kept ſome Time in the exhauſted Receiver of an Air-Pump. It is affirmed, that neither did the tied Nerve ſwell between the Brain and Ligature, nor was there any Liquor collected in the Receiver of the Air-Pump, from which it is concluded that there is no Liquor in the Nerves.

There is ſome Difference among thoſe who ſay they have tried theſe Experiments, ſome affirming that in young Animals the Nerve does ſwell above the Ligature, and that a Liquor does drill out upon cutting a Nerve. But allowing the Experiments to ſucceed any way, the Reply to the Inference from them is, that in neither way are they any thing to the Purpoſe; for the ſwelling of the Nerve after it is tied, or the Efflux of Liquors from its Extremity, will never prove either to be the Effect of the Fluid in the proper nervous Fibrils, ſo long as they might be occaſioned by the Liquors in the larger Veſſels of the cellular Subſtance of the Nerves; and if theſe ſame Veſſels of the Coats of the Nerves do not diſcover their Liquors by theſe Experiments, it is far leſs to be expected that the much more ſubtile Nerves ſhould.

39. The 3*d* Objection to the Doctrine of the Brain being a Gland, and the Nerves its Excretories, ſuppoſes a more rapid Motion neceſſary in the Fluid of the Nerves, than what moſt of the Defenders of the nervous Fluid will now allow, and is afterwards to be conſidered particularly in a more proper Place.

40. The 4*th* Objection being, that if Nerves are Excretories of a Gland, they muſt be cylindrical Pipes, in which no Obſtructions or Diſeaſes would happen; but ſince we daily ſee Diſeaſes in the Nerves, they muſt therefore not be ſuch Excretories. The Anſwer is, That Diſeaſes happen often in the Excretories of other Glands as of the Liver, Kidneys, *&c.*

notwithſtanding their cylindrical Form, and their much ſhorter and leſs expoſed Courſe. When we conſider the very tender Subſtance of the Brain; the vaſt Complication of Veſſels there; the prodigious Smalneſs of the Pipes going out from it; the many moving Powers which the Nerves are to undergo the ſhock of; and the many Chances which the Veſſels, Membranes and cellular Subſtance accompanying the Nerves have of being diſordered, and then affecting the nervous Fibrils, we have very great Reaſon to be ſurprized, that theſe cylindrical Pipes are not much more frequently put out of Order by too great or too ſmall a Quantity of Liquors; by too viſcid or too thin Fluids; by Liquors conſiſting of too mild and ſluggiſh Particles, or of too acrid pungent ones; by too great or too little Motion given to the Liquors; by the Diameters of the Pipes being too much ſtraitned, or too much enlarged; and by a great many other Varieties of Circumſtances which might be ſuppoſed capable of diſturbing the Functions of the Nerves, ſuppoſing them to be cylindrical Excretories of the Gland the Brain.

41. The numerous Veſſels of the *Encephalon* have brought ſome of the Gentlemen who defend the Opinion of the Nerves being ſolid, to acknowledge, that there is a Liquor ſecreted in the Brain; but then they will not allow that this Liquor is ſent out by the proper nervous Fibrils, but that it is poured into the cellular Subſtance in which the Nerves ly, to keep them moiſt and ſupple, and therefore fit for exerting their Elaſticity, Vibration, *&c.*

by which, in their Opinion, the Effects commonly aſcribed to Nerves are produced.

42. Beſides the Objections already mentioned (§ 31, 32,) againſt the Nerves acting as elaſtick Strings, this Opinion has ſome other Difficulties attending it, that may be urged as Objections to it; ſuch as, there is not one Example in the Body of Liquors ſecreted in a large Gland being poured into a cellular Subſtance, as here ſuppoſed; the Liquors in the Cells of the *tunica cellularis* of other Parts are ſeparated from the little Arteries which are diſtributed to theſe Cells.

Further, it can't be well determined, how a Liquor ſecreted in the *Cortex* of the Brain ſhould make its Way through the *Medulla* to come out into the cellular Membranes on the Surface of that *Medulla*.

Laſtly, A very ſimple Experiment of injecting Water by the Artery of any Member, and thereby filling the cellular ſubſtance of the Nerves of that Member, ſhews evidently that the Liquor of the *tunica cellularis* of the Nerves has the ſame Fountain as the Liquor in the *tunica cellularis* has any where elſe, that is, from the little Arteries diſperſed upon it.

43. The Doctrine of a Fluid in the Nerves is not only thus ſupported by the Analogy of the Brain and Nerves to the other Glands and their Excretories, but thoſe who maintain this Doctrine mention an Experiment which they think directly probative of a Fluid in the Nerves; it is this. After opening the Thorax of a living Dog, catch hold of and preſs one or both the phrenic Nerves with the Fingers, the *Diaphragm* immediately ceaſes

to contract; then let go the hold of the Nerves, and the Muſcle acts again: Pinch a ſecond time the Nerve or Nerves ſome way above the *Diaphragm*, this Muſcle again ceaſes to act: Keep firm the Hold of the Nerve, and with the Fingers of the other Hand ſtrip it down from the gripping Fingers towards the *Diaphragm*, and the Muſcle is made to contract; and for three or four ſuch Stripings its Action follows or obeys the Motion of the Fingers which ſtrip it down; then it becomes diſobedient, and will contract no more, ſtrip as you will, unleſs the Fingers gripping or pinching the Nerve let go their Hold, or are removed higher up upon the Nerve, when the Muſcle may again be made to contract by ſtripping the Nerve down towards it. This Experiment I have done with the Succeſs here mentioned. Let any one try if he can imagine any other reaſonable Account of theſe Appearances, than that the gripping Fingers ſtopt the Courſe of a Fluid in the Nerve; that what of this Fluid was thus made to ſtagnate in the Part of the Nerve between the gripping Fingers and *Diaphragm*, was forced down into that Muſcle by the Preſſure of the Fingers which ſtripped the Nerve down; and when ever this ſtagnating Fluid was preſſed all away by ſeveral Repetitions of ſtripping the Nerve, the Muſcle being ſupplied with no more Fluid contracted no more, till upon removing the Fingers which had hold of the Nerve, a new Supply of Liquor was brought from the Brain, or from the Part of the Nerve that had not yet been grip'd or ſtripped; and when ever this Liquor could make its Way down to the Muſcle, or was forced down to it, the Muſcle immediately began to renew its contractile Motions.

44. Some Gentlemen convinced of the Reaſonableneſs of the Secretion of a Liquor in the Brain to be ſent out by the Nerves, but not comprehending how a Fluid could have ſuch a rapid retrograde Motion as they imagined was neceſſary for conveying the Impreſſions of Objects made on the Extremities of Nerves to the *Senſorium*, ſuppoſed two Sorts of Nerves, one that conveyed a Liquor for muſcular Motion and Nutrition; the other compoſed of ſolid Nerves, that were to ſerve for the Organs of the Senſes, to convey the Vibrations communicated from Objects to the *Senſorium*.

45. The Objections mentioned (§ 31.) againſt the ſenſatory Nerves acting by Vibrations take place here: And further, there is nothing in the Texture either of the Brain or Nerves, which gives any Reaſon to think, that the Nerves are differently formed; on the contrary, the Structure is every where ſimilar, and often Branches of the ſame Nerve ſerve both for Senſation and Motion. What occaſioned juſtly a Prejudice againſt the Scheme of our Senſations depending on a Fluid in the Nerves, to wit, the rapid Refluxes ſuppoſed in the ſenſitive Nerves, is an Opinion now deſerted generally by the Defenders of the nervous Fluid, for Reaſons to be given in a little, tho' their Opponents are ſtill willing to palm it on them, whereby they may have a better Handle againſt the general Doctrine of the nervous Fluid.

46. This ſame rapid Reflux it was too, which gave Riſe to another Diviſion of the Nerves into arterious or effluent, and venous or refluent.

ent. It was ſaid, that muſcular Motion and Nutrition depended on the arterious Nerves, and that the Senſations depended on an accelerated Motion of the nervous Fluid towards the Brain, by the Impreſſions which the Objects of the Senſes make upon the venous Nerves. By this Suppoſition the Abſurdity of rapid Fluxes and Refluxes in the ſame Canal was prevented, and an Advantage was thought to be gained by it, of ſaving too great a Waſte of the Fluid of the Nerves, which otherwiſe the *Encephalon* and *Medulla ſpinalis* could not ſupply in ſufficient Quantity to anſwer all the Exigencies of Life.

47. To this Opinion (§ 46.) it has been objected, 1. That there is no Example in the Body of a ſecreted Liquor being returned immediately and unmixed to the Gland by which it was originally ſeparated from the Maſs of Blood, which would be the Caſe were there venous Nerves. 2*dly*, There is no Occaſion for ſaving the Fluid of the Nerves in the Way propoſed, the Organs for ſecreting that Fluid being large enough to ſupply all that is neceſſary of it in the common Functions of Life. 3*dly*, If the Fluid of the Nerves was to be thus kept in a perpetual Circulation, it would ſoon become too acrid for continuing with ſafety in ſuch ſenſible tender Veſſels as the Brain and Nerves are compoſed of. 4*thly*, This Hypotheſis will not anſwer the Deſign for which it was propoſed. For tho' the momentary Application of an Object might cauſe an Acceleration in the Fluid of venous Nerves, yet if the Object was kept applied to the Nerves, it would ſtop their Fluid, ſo that it could not go

forward to the Brain; and therefore, according to this Doctrine, we ſhould be ſenſible of no Objects, except thoſe whoſe Application to the Organs of the Senſes was momentary.

48. Let us now ſuppoſe it probable, that the *Encephalon* and *Medulla ſpinalis* ſecern a Liquor from the Blood which is ſent into all the Nerves, and that by the Means of this Liquor the Nerves perform the Offices commonly aſſigned to them, it is neceſſary to enquire what Kind of Liquor this is, and how it moves, in order to determine how well its Nature and Motion are fitted for performing what is expected from it.

49. It has been ſuppoſed, that the Liquor of the Nerves was of a very ſtrong acid or alcaline Nature; but ſince we can ſee none of our Juices of ſuch Natures, and ſince ſuch Liquors irritate and deſtroy the Parts of the Body they are applied to, we can never imagine that the Brain could ſeparate, or the Nerves could bear any Thing of ſuch an acrid Nature; and this ſame Tenderneſs and Senſibility of theſe Organs muſt hinder us to ſuppoſe the Liquor of the Nerves can be acrid or pungent of any Kind, as of the Nature of inflammable Spirits, Spirit of Harthorn, *&c.*

50. Some have imagined the Liquor of the Nerves to be capable of vaſt Exploſion, like Gunpowder, or of violent ſudden Rarefaction like Air, or of ſtrong Ebullition like boiling Water, or the Mixture of Acids with alkaline Liquors. But as none of the Particles of our Maſs of Blood, from which this Liquor of the Nerves muſt be derived, enjoy any ſuch Properties, we cannot ſuppoſe the Blood to fur-

niſh what it has not. Beſides, all theſe Operations are too violent for the Brain or Nerves to bear; and when once they are begun, are not ſo quickly controuled or put an End to, as Experience teaches us the Nerves can be made to ceaſe from acting.

51. We know not ſufficiently the Properties of an *Æther* pervading every Thing, to pretend to apply it to the animal Functions, eſpecially where we muſt ſuppoſe it ſent a great Way in a long Cord, in which we cannot conceive how it ſhould be confined; which are Difficulties not to be ſurmounted in accounting for the Functions of Nerves by Means of ſuch an *Æther*.

52. The ſureſt Way of judging what Kind of Liquor this of the Nerves muſt be, is to examine the Liquors of ſimilar Parts of the Body. All the Glands ſeparate Liquors from the Blood much thinner than the compound Maſs itſelf; ſuch is the *Liquor* poured into the Cavity of the *Abdomen*, *Thorax*, *Ventricles of the Brain*, the *Saliva*, *pancreatic Juice*, *Lymph*, &c. Whereever there is Occaſion for ſecreted Liquors being thick and viſcid, in order to anſwer better the Uſes they are intended for, Nature has provided Reſervoirs for them to ſtagnate in, where their thinner Parts may be carried off by the numerous abſorbent Veins diſperſed on the Sides of thoſe Cavities, or by flying off where there is a Communication with the external Air. The *Snot of the Noſe* is very thick commonly by ſtagnating; but when the Secretion of the Membrane of the Noſe is increaſed by blowing the Noſe, or by Sternutatories, we ſee it very thin and watry; there is

not then Time for the Air or Abſorbents to carry off the more watry Particles. The *Cerumen* of the Ears is of a watry Conſiſtence, when ſqueezed out before it has ſtagnated. The *Mucus* of the alimentary Canal is concocted in *Lacunæ*. The *Bile* in the hepatick Duct is lymphatick; that in the Gall-bladder is viſcid and ſtrong. The *Urine* is much more watry as it comes from the Kidneys, than when it is excreted from the Bladder. The *Seed* is thin as it comes from the Teſticles, and is concocted in the *Veſiculæ ſeminales*, &c.

53. From § 52. we may ſafely conclude, that the Secretion of a thin Liquor is made in the *Cortex* of the *Encephalon* and *Medulla ſpinalis*; and ſeeing the Thinneſs of ſecreted Liquors is generally as the Diviſions of the Veſſels into ſmall ſubtile Branches, and the Ramifications within the Skull are carried on to a very great Subtilty, the Liquor ſecreted in the *Encephalon* may be determined to be among the fineſt or thinneſt Fluids.

54. Seeing we can obſerve no large Reſervoire, where the Liquor ſecerned in the *cortical Subſtance* is depoſited, to have its finer Parts taken off, we have Reaſon to think, that it goes forward into the Nerves in the ſame Condition in which it is ſecerned.

55. By fine or ſubtile animal Liquors is meant no more than thoſe which are very fluid, conſiſting of a large Proportion of watry Particles, and a leſſer one of the oily, ſaline and terreſtrious Particles. Some of the Liquors which we can have in ſufficient Quantity to make Experiments with, are ſo fluid, and have ſo little Viſcidity or Coheſion of Parts,

that

that when laid on a Piece of clean Mirrour, they will evaporate without leaving a Stain on the Mirrour, ſuch is the Liquor drilling out on the Surface of the Pleura, the Lymph, and ſeveral others.

If then theſe Liquors, which are ſubject to our Examination, the ſecerning Veſſels of which are ſo large that we can ſee them, have ſuch a ſmall Coheſion of Parts, it might not be unreaſonable to ſay, that the Liquor of the Nerves is as much more fine and fluid than Lymph, as the Veſſels ſeparating it are ſmaller; and therefore that the Fluid of the Nerves is a defecated Water with a very ſmall Proportion of *animal Sapo* diſſolved in it.

56. Two Experiments are ſaid to contradict this Opinion of the Liquor of the Nerves being ſo fluid and ſubtile. One is, that upon cutting the *Cauda equina* of a living Animal, a Liquor as viſcid as the White of an Egg drops out: The other is, that a wounded Nerve yields a *glairy Sanies.* But theſe are no Proof that the Liquor of the Nerves is of the ſame Nature, ſince it is evident that the Liquor diſcharged in both theſe Caſes, comes out of the cellular Subſtance involving the nervous Fibrils.

57. Conſidering how many Experiments make it evident, that there is a conſtant uninterrupted Stream of Liquors flowing through all the Canals of Animals, which convey Liquors, whoſe Particles are not larger than the Diameter of their Canal, which never is the Caſe in a natural State of excretory Veſſels, it is ſurprizing how the Opinion ever ſhould have

been taken up of the Liquid of the Nerves being obliged to make ſuch a prodigious rapid Courſe, as to flow from the Brain to each Muſcle inſtantaneouſly when we will to contract it; or that this Liquor ſhould flow back with the like Celerity from the Extremity of each Nerve, to which an Object of Senſation was applied. The Nerves, as well as the other Excretories of the Glands are always full of Liquors, the Degree of Diſtenſion of the Canals by the Liquors being, even in a ſound natural State, ſometimes more, and ſometimes leſs, the Sides of the Tubes being ſtretched to make way for a larger Quantity, and contracting to accommodate themſelves to a leſſer Quantity; as much Liquor as does Violence to the Sides of the Canals in ſtretching, or ſo little as the Sides cannot contract to, both occaſion Diſeaſes.

58. The Motion of the Fluid in the Nerves will not only then be conſtant, but it will alſo be equal, or nearly ſo: For tho' the Blood in the larger Arteries is moved unequally by the unequal Forces, the Contraction of the Ventricle of the Heart, and the weaker Power, the Syſtole of the Arteries, yet the Difference between theſe two moving Powers comes to be leſs and leſs perceptible, as the Arteries divide into ſmaller Branches, becauſe of the numerous Reſiſtances the Liquors meet with, and becauſe the Canals they move in become larger, till in the very ſmall arterious Branches there is no Difference in the Velocity of the Liquors from the Effect of the Heart or Arterie. The Motion of the Fluids muſt ſtill be more equal in the Excretories of Glands,

and particularly in thoſe where the Veſſels have divided into very minute Branches. So that the nervous Fluid will move conſtantly, equally and ſlowly for ordinary; but this natural Courſe may be alter'd by the Influence of the Mind, or by the Preſſure of ſome neighbouring active Organ.

59. We have perhaps no Idea of the Manner how Mind and Body act upon each other; but if we allow that the one is affected by the other, and that the Fluid of the Nerves (whatever Name People pleaſe to give it) is a principal Inſtrument which the Mind makes uſe of to influence the Actions of the Body, or to inform itſelf of the Impreſſions made on the Body, we muſt allow that the Mind can direct this Inſtrument differently, particularly as to Quantity and Celerity.

60. Let us now ſuppoſe the nervous Fluid ſuch as has been argued for, to wit, an extreme Fluid ſaponaceous Water, moving in a conſtant, equal, ſlow Stream from the *Encephalon* and *Medulla ſpinalis* in each of the proper nervous Fibres, except when the Motion is changed by ſome acceſſory Cauſe, ſuch as the Mind, Preſſure of other Parts, *&c.* and let us examine how well ſuch a Suppoſition will agree with the Phænomena of the three great Functions, Nutrition, Senſation and muſcular Motion, which the Nerves are principal Inſtruments of.

In general we may well enough ſay, that Nerves can carry Fluids to the moſt minute Part of the Body, to ſupply what is waſted in any of the ſolids; that the Impreſſion made by the Objects of the Senſes on the very ſoft pulpy py Extremities of the Nerves of the Organs of the Senſes, muſt make ſuch a Stop in the equal-flowing nervous Fluid, as muſt inſtantaneouſly be perceptible at the Fountain-head from which the preſſed Pipes come; That the conſtant Flow of the Liquor of the Nerves into the Cavities of the *muſcular Fibrillæ*, occaſions the natural Contraction of Muſcles, by the conſtant *niſus* it makes to increaſe the tranſverſe Diameter, and to ſhorten the longitudinal Diameter of each Fibre, and that it is only to allow the Mind a Power of pouring a greater Quantity of this ſame Fluid with a greater Velocity, into what muſcular Fibres it pleaſes, to account for the voluntary ſtrong Action of Muſcles.

61. But ſince ſuch a ſuperficial Account would not be ſatisfactory, it will be expected, that the principal Phænomena of theſe three Functions are to be explained by the Means of ſuch a Fluid as has been ſuppoſed, and that the ſeveral Objections againſt this Doctrine ſhould be anſwered: Let us attempt this, and where we cannot extricate ourſelves from Difficulties which may be thrown in, let us boldly acknowledge Ignorance.

62. *α*. If Water, with a very ſmall Proportion of Oils and Salts from the Earth, proves a fit Nouriſhment for Vegetables, ſuch a Liquor as the Fluid of the Nerves has been deſcribed (§ 55.) may not be unfit for repairing the Waſte in Animals.

β. The ſlow conſtant Motion of this nervous Fluid (§ 57, 58.) to the moſt minute Parts of the Body (§ 9.) is well enough calculated to ſupply the Particles that are conſtantly carried away from the Solids by the *Vis Vitæ*, Circulation of the Liquors and neceſſary Actions of Life.

γ. The greater proportional Size of the *Encephalon*, the great Fountain of this nutritious Liquor of the Nerves, in Creatures the younger they are, ſeems very well calculated for their greater proportional Growth at that time of Life.

δ. A Palſy and Atrophy of the Members generally accompanying each other, ſhew, that Nouriſhment, Senſation and Motion do depend on the ſame Cauſe.

ε. It was ſaid (§ 25.) that the Nerves were *principal* Inſtruments in Nutrition, it was not affirmed, that they were the *ſole* Inſtruments; and therefore an *Atrophy* may proceed from the Compreſſion or other Leſion of an Artery, without being an Objection to the Doctrine here laid down.

63. *a.* All Objects of our Senſes act by Impulſe, when they are applied to their proper Organs. Tangible Objects evidently preſs on the Surface of our Bodies: Odorous Particles need the Aſſiſtance of Air moved rapidly to affect our Noſe: Sapid Subſtances often are not ſufficient to give us any Idea of their Taſte by their own Weight, but need the Aſſiſtance of the Preſſure of the Tongue upon the Palate: The Rays of Light collected into a *Focus* drive light Bodies before them: Sound communicates a Vibration to all Bodies in harmonic Proportion with it. The Impulſe made thus by any of theſe Objects on the ſoft pulpy Nerves (§ 20.) which are full of Liquor, will preſs their Sides or Extremities, and their Li-

quor will be hindred to flow ſo freely as it did. The Canals being all full, (§ 57.) this Reſiſtance muſt inſtantaneouſly affect the whole Canals that are preſſed and their Origins, and have the ſame Effect, as if the Impulſe had been made upon the Origin itſelf. To illuſtrate this by a groſs Compariſon, let any one puſh Water out of a Syringe through a long flexible Pipe, fixed to the Syringe, he will be ſenſible of Reſiſtance, or a Puſh backwards inſtantaneouſly, as any other puts his Finger on the Orifice of the Pipe, or grips the Sides of it. This Impulſe made on the Nerves, and thus communicated to their Origin, will vary according to the Strength or Weakneſs, the Quickneſs or Slowneſs, the Continuance or ſpeedy Removal, the Uniformity or Irregularity, the Conſtancy or Alteration, *&c.* of the Application of the Objects to the Nerves.

b. Whenever the Impulſe proper to the Object is regularly applied with due Force to a Nerve rightly diſpoſed to be impreſſed by it, and is communicated, as juſt now explained, to the *Senſorium*, it gives a true and juſt Idea of the Object to the Mind.

c. The various Kinds of Impulſes, which the different Claſſes of Objects make, occaſion a Neceſſity of having the different Organs of the Senſes variouſly modified, ſo that the ſeveral Impulſes may be regularly applied to the Nerves in each Organ, or in other Words, we muſt have different Organs of the Senſes fitted to the different Claſſes of Objects.

d. As the Objects have one common Property of Impulſe, ſo all the Organs have moſt of the Properties of the Organ of Touching in common with the *Papillæ* of the Skin. In the Noſe and Tongue this is evident; in ſome Operations on the Eyes we can alſo perceive this, as we may likewiſe do in ſome Caſes, where Matter is collected in the internal Ear.

e. Theſe Properties common as well in the Objects as the Organs, occaſion frequently uncommon Effects in the Application of an Object to an Organ proper to another Object of Senſation; for ſometimes we have the ſame Idea, as if the Object had been applied to its own proper Organ; at other times the Object is as it were changed, and we have the Idea as if the Organ had had its own proper Object applied to it. Thus, for Example, Light is the proper Object to be applied to the Eye, to give us any Idea of Colours; yet when all Light is excluded from the Eyes, an Idea of Light and Colours may be excited in us by Coughing, Sneezing, Rubbing, or ſtriking the Eye-ball.—— A Cane vibrating by a Stroke, but not ſo as to give any Sound perceptible to the Ear, if it is applied to the Teeth, it raiſes a ſtrong Idea of Sound, as will alſo a little Inſect crawling in the *Meatus auditorius*.——The Fingers applied to two rough Surfaces, rubbing on each other, are ſenſible of the Sound they make; Surgeons of any Practice in the Cure of fractured Bones can bear Witneſs to the Truth of this.—— The Fingers dipped in acid and ſeveral other acrid Liquors, have a Senſation very like to Taſting.—— Smelling and Taſting every Body knows are ſubſervient and aſſiſting to each other. From ſuch Examples we have further Proof of one general Cauſe of our Senſations, to wit, Impulſe from the Objects; and that any one of the Organs would be capable of producing the Effect of another, if the Impulſes of the different Objects could be regularly applied to each.

f. If the Impulſe of an Object is applied with due Force, but irregularly, a confuſed Idea of the Object is raiſed. Diſtant Objects are confus'd to *Myopes*, as very near ones are to *Presbytæ*.

g. If the Application of the Impulſe is regular, but the Force with which it is applied is too weak, our Perception of the Object is too faint. One may whiſper ſo low as not to be heard.

h. If the Application of Objects is too violent, and there is any Danger of the tender Organs of our Senſes being leſed or deſtroyed, the uneaſy Senſation we call *Pain* is raiſed, whatever the Organ thus leſed is. The Objects of Touch affect every Organ: Thus Preſſure, cutting, pricking, Salts, pungent Oils, great Heat, violent Cold, *&c.* occaſion Pain, whereever they are applied. Beſides this, every particular Organ can be affected with Pain, by the too violent Application of its own proper Object. Too much Light pains the Eyes; very loud Sound ſtuns the Ears; very odorous Bodies and too ſapid Objects hurt the Noſe and Tongue. A pretty ſure Proof this of the Objects of our Senſes all acting, and of the Organs all being impreſſed in nearly the ſame Way.

i. Whenever this uneaſy Senſation, *Pain*, is thus raiſed, a Sort of Neceſſity is as it were impoſed upon the Mind, to endeavour to get free of the injuring Cauſe, by either withdrawing the leſed Part of the Body from it, as one retires his Hand when his Finger is pricked or burnt; or the injuring Cauſe is endeavoured to be forced from the Body, as a *Teneſmus* puſhes acrid *Fæces* out of the *rectum*. In both theſe Operations a convulſive Contraction is immediately made in the leſed Part, or in the Neighbourhood of it; and if the Irritation is very ſtrong or permanent, the greater Part of the nervous Syſtem comes to be affected in that ſpaſmodic or convulſive Way.

This *Niſus* of the Mind to free the Body of what is in Danger of being very hurtful, may ſerve to explain the Phænomena of a great many Diſeaſes, when we are acquainted with the Diſtribution of the particular Nerves; and from this we can underſtand the Operation of Medicines that ſtimulate, and may learn how by exciting a ſharp but momentary Pain, we may free the Body of another Pain that would be more durable; and that by having it thus in our Power to determine a flow of the Liquor of the Nerves to any particular Part, for the Benefit of that Part or the Relief of any other diſeaſed Part, we can do conſiderable Service by a right Application of the proper Medicines.

k. If a Pain-giving Cauſe is very violent or long continued, it deſtroys the Organs either irrecoverably, or puts them ſo much out of Order, that they only gradually recover. People have been made blind or deaf for all their Lives after, by the violent Effect of Light on their Eyes or Sound on their Ears, and we are frequently expoſed to as much Light and Sound as make us unfit to ſee or hear for a conſiderable Time after. I would explain this by a Ligature put round the tender Branch of an Herb; this Ligature drawn to a certain Degree may weaken the Canals ſo as to be unfit for the Circulation of the Juices a good While, till they are gradually explicated and made firm by theſe Juices. A ſtricter Ligature would diſorder the Structure of the Fibres ſo much, that the Liquors could not recover them. The Analogy is ſo plain it needs no Commentary.

64. 1. In applying the Fluid of the Nerves to the Action of Muſcles, it was ſaid that natural or involuntary Contraction of Muſcles was the *Niſus* which the nervous Fluid flowing conſtantly into the muſcular Fibres makes to diſtend theſe Fibrils, by enlarging their tranſverſe Diameters and ſhortning their Axes, and that voluntary Contraction was owing to a greater Quantity of that nervous Liquor determined towards the Muſcle to be put in Action, and poured with a greater *momentum* into the muſcular Fibrils by the Power of the Mind willing to make ſuch a Muſcle to act.

2. It has been objected to this account of muſcular Motion, that if it was true, the Volume of a Muſcle in Contraction neceſſarily would be conſiderably increaſed by ſo much Liquor poured into its Fibrils, whereas it does not appear by any Experiment, that the Volume of a Muſcle is increaſed by its being put into Action.

3. To this it has been anſwered, That the Spaces between the muſcular Fibres are ſufficient to allow the Fibrils ſwelling during the Contraction of a Muſcle to lodge in, without

any Addition to the Bulk of the Muſcle; and that it plainly appears that theſe Spaces between the Fibrils are thus occupied, by the Compreſſion which the larger Veſſels of Muſcles, which run in thoſe Spaces, ſuffer during the Action of a Muſcle; it is ſo great that the Muſcle becomes pale by contracting.

4. Another Objection to the Action of Muſcles being owing to the Influx of a Fluid into their Fibrils is, that muſcular Fibres are diſtractile, or capable of being ſtretched; and therefore when a Fluid is poured into their hollow Fibrils, they would be ſtretched longitudinally, as well as have their tranſverſe Diameters increaſed, that is, a Muſcle would become longer as well as thicker when it is put in Action, whereas it is known to every Body that a Muſcle is ſhortned when acting.

5. In Anſwer to this it has been remarked, that tho' muſcular Fibrils are diſtractile, yet they will not yield to, or be ſtretched by every Force however little that might be applied to them, a Cord that can be ſtretched in Length by the Weight of a Pound or two, might not yield in the leaſt to an Ounce or two; and it muſt likewiſe be obſerved, that gradually as any Body is ſtretched, its Reſiſtance to the ſtretching force increaſes. A Rope may be ſtretched to a certain Length by a Pound Weight appended to it, which would require two Pounds to ſtretch it very little further; and therefore the general Obſervation of Animal Fibres being diſtractile, cannot be a reaſonable Objection to the account of muſcular Motion above-mentioned, unleſs a Proof is brought that the Force which the Liquid of

the Nerves muſt exert upon each Fibre of a Muſcle in order to make a Muſcle act, is capable of diſtracting or ſtretching the Fibres, which has not yet been attempted to be proved.

6. If muſcular Motion depends on the Influx of the nervous Liquid, the inſtantaneous Contraction of a Muſcle, when the Mind wills to make it act, will eaſily be underſtood from the Nerves being always full of their Liquor, (§ 57.)

7. If either the Nerves of any Muſcle do not furniſh a ſufficient Quantity of their Liquor, or if the Fibres of a Muſcle become too eaſily diſtractile, ſuch a Muſcle will be unactive or paralytick.

8. If too great a Quantity of the Liquor of the Nerves is determined to a Muſcle or Muſcles, by any Cauſe which the Mind cannot command, ſuch Muſcle or Muſcles will be convulſed.

9. If the Motion of the Liquid of the Nerves is not uniform, but by Diſeaſe becomes irregular, an alternate Relaxation and Contraction of Muſcles may be the Conſequence, hence trembling Palſies, *chorea ſancti Viti*, &c.

10. Tho' the Nerves may not furniſh as much Liquor as may be ſufficient to make Muſcles contract with Strength enough to overcome the Reſiſtances to their Action, yet there may be enough of Liquor in the Nerves to allow the Impreſſions of Objects to be conveyed to the *ſenſorium*; this may be one Cauſe of a Member's being ſometimes ſenſible after it cannot be moved.

11. Unleſs the Liquor of the Nerves acquires ſome Energy in the Brain, which we

have no Reaſon to think the Circulation of the Fluids in the Veſſels can give it, or unleſs it has Properties other than what we can diſcover in it, or unleſs there is an active Agent determining its *momentum* towards ſome particular Parts, which we are not conſcious of; if ſome of theſe don't obtain the Action of the Heart continuing of equal Force to propel our Liquors, notwithſtanding all the Reſiſtances that are to it, is not to be explained.

12. All Muſcles, but eſpecially the Heart, will continue to contract in an irregular Way, after they are cut away from the Animal to whom they belonged, which may be owing to the Liquors continuing to flow in the ſmall Veſſels, and being poured irregularly into the muſcular *Fibrillæ*.

13. After the Heart or any other Muſcle cut away from an Animal has ceaſed to contract, its Contraction may again be reſtored by blowing one's warm Breath upon it, or pricking it with any ſharp Inſtrument; that Heat or Pricking ſhould by their *ſtimulus* (§63. 1.) occaſion Contraction in a living Creature may be underſtood; but how they ſhould have the ſame Effect in a Muſcle ſeparated from an Animal, I know not.

N. B. Num. 11, 12, 13 are as inexplicable upon any other Suppoſition yet made concerning muſcular Motion.

65. I know no Experiment or Obſervations by which any Thing can be proved, or from which any Thing can be reaſonably inferred concerning the Uſes of the *Ganglions* of the Nerves, and therefore pretend to give no Account of them.

Of the particular Nerves.

THERE are generally ſaid to be forty Pair of Nerves in all, of which ten come out from the *Encephalon*, and the other thirty have their Origin from the *Medulla ſpinalis*.

Of the ten Pair of Nerves that are generally ſaid to come from the *Encephalon*, the firſt is the *OLFACTORY*, which long had the Name of the *Mammillary Proceſſes* of the Brain, becauſe in the Brutes which were moſt commonly diſſected, their Form has ſome Reſemblance to a Nipple; for they are large where they begin to go out from the Brain, and taper a little as they go forwards to the cribriform Part of the *Ethmoid* Bone; and becauſe in theſe Animals they are evidently Continuations or Productions of the two anterior Ventricles of the Brain, being hollow and containing Lymph, the Antients believed that theſe Nerves ſerved to convey the ſuperfluous *Mucus* from the cold moiſt Brain, to be evacuated by the Holes of the cribriform Bone into the Noſe. But in Man theſe Nerves are ſmall, long, and without any Cavity, having their Origin from the *corpora ſtriata*, near the Part where the internal carotid Arteries are about to ſend off their Branches to the different Parts of the Brain, and in their Courſe under the anterior Lobes of the Brain, which have a Depreſſion made for lodging them, the human olfactory Nerves become larger till they come to the cribriform Bone where they ſplit into a great Number of ſmall Filaments to paſs thro' the little Holes in that Bone, and then each being joined by a Branch of the fifth Pair of Nerves is ſpread on the Membrane of the Noſe.

The tender Structure and ſudden Expanſion of theſe Nerves on ſuch a large Surface render it impoſſible to trace them far; which has made ſome Authors deny them to be Nerves: But when we break the Circumference of the *cribriform Lamella*, and then gently raiſe it, we may ſee the Diſtribution of the Nerves ſome way on the Membrane of the Noſe.

The Contrivance of defending theſe long ſoft Nerves from being too much preſſed by the anterior Lobes of the Brain under which they lye, is ſingular, becauſe they have not only the prominent orbitar Proceſſes of the frontal Bone, and the *Criſta Galli* of the *Ethmoid* Bone to ſupport the Brain on each Side, with the *Falx* by means of the Veins going into the longitudinal Sinus, and other Attachments bearing it up in the Middle, but have a Groove formed in each Lobe of the Brain itſelf for them to lodge in. Their ſplitting into ſo many ſmall Branches before they enter the Bones of the Skull is likewiſe peculiar to them; for generally the Nerves come from the Brain in diſgregated Filaments, and unite into Cords, as they are going out at the Holes of the Bones: But we ſhall find that this Contrivance is the beſt for anſwering the Purpoſe they are deſigned for, of being the Organ of ſmelling; for had they been expanded upon the Membrane of the Noſe into a medullary Web, ſuch as the optic Nerve forms, it would have been too ſenſible to bear the Impreſſions of ſuch Objects as are applied to it, and a Diſtribution in the more common way of a Cord ſending off Branches, would not have been equal enough for ſuch an Organ of Senſation.

The 2*d* Pair of Nerves are the *OPTIC*, which riſe each from the *thalami nervorum opticorum*, and then after making a large Curve outwards, run obliquely inwards and forwards till they unite at the Fore-part of the *Sella Turcica*, and then dividing again, each runs obliquely forwards and outwards to go out at its proper Hole in the ſphenoid Bone, accompanied with the proper ocular Artery, to run afterwards to the Globe of the Eye, within which each is extended into a very fine Cup-like Web that lines all the In-ſide of the Eye as far forwards as the *ciliary Circle*, and is univerſally known by the Name of *Retina*.

Tho' the Subſtance of theſe two Nerves ſeems to be blended at the Place where they are joined, yet Obſervations of People whoſe optic Nerves were not joined at all, and of others who have been blind of one Eye from a Fault in the optic Nerve, or in thoſe who have had one of their Eyes taken out, make it appear that there is no ſuch intimate Union of Subſtance, the optic Nerve of the affected Side only being waſted, while the other was large and plump; and the ſame Obſervations are contradictory to the Doctrine of a Decuſſation of all the Nerves (§ 7.); for the Diſeaſe could be traced from the affected Eye to the Origin of the Nerve on the ſame Side. In many Fiſhes indeed the Doctrine of Decuſſation is favoured, for their optic Nerves plainly croſs each other without any Union at the Part where they are joined in Men and moſt Quadrupeds.

Thoſe People, whoſe optic Nerves were not joined, having neither ſeen Objects double, nor turned their Eyes different Ways, is alſo a plain Proof that the Conjunction of the optic Nerves will not ſerve to account for either the uniform Motions of our Eyes, or our ſeeing Objects ſingle with two Eyes.

The *Retina* of a recent Eye, without any Preparation, appears a very fine Web, with ſome Blood-veſſels coming from its Center to be diſtributed on it; but after a good Injection of the Arteries that run in the Subſtance of this Nerve as is common to other Nerves, it is with Difficulty that we can obſerve its nervous medullary Subſtance. As theſe Veſſels are placed in the centrical Part of the optic Nerve, and there are not medullary Fibres here, where it enters the Ball of the Eye: This may be one Reaſon why we do not ſee ſuch Bodies or Parts of Bodies, whoſe Picture, formed on the Bottom of our Eye, falls on this centrical Part of the *Retina*. An Inflammation in thoſe Arteries of the *Retina*, which an *Opthalmia* is generally attended with, may very well account for that Tenderneſs in the Eyes, and Inability to bear the Light which People have in that Diſeaſe. The Over-diſtenſion of theſe Veſſels may likewiſe ſerve to account for the black Spots obſerved on bright coloured Bodies eſpecially, and that ſmoaky Fog, thro' which all Objects are ſeen by People in ſome Fevers. If thoſe Veſſels loſe their Tone and remain preternaturaly diſtended, no Ob-

Objects may affect our *Retina*, tho' the Eye externally appears ſound, or this may be one Cauſe of an *Amauroſis* or *Gutta ſerena*.

The *THIRD PAIR* riſe from the anterior Part of the *Proceſſus annularis*, and piercing the *Dura Mater* a little before and to a Side of the lateral Extremities of the poſterior clinoid Proceſs of the ſphenoid Bone, run along the *Receptacula*, or *cavernous Sinuſes*, at the Side of the *Ephippium*, to get out at the *Foramina lacera*, to be diſtributed to the Globe of the Eye, to the *Muſculus rectus* of the *Palpebra*, and to the *Attollens*, *Adductor*, *Deprimens* and *obliquus minor* Muſcles of the Eye-ball. Theſe Muſcles being principal Inſtruments in the Motions of the Eye-lid and Eye-ball, the Nerve has therefore got the Name of the *Motor Oculi*. I have frequently obſerved in Convulſions the Eye-lids widely opened, the *Cornea* turned up and outwards, and the Eye-balls ſunk in the Orbit; which well deſcribed the conjunct Action of the Muſcles which this Pair of Nerves ſerves. Poſſibly the Diſtenſion of a conſiderable Branch of the Carotid, which paſſes over this Nerve near its Origin on each Side, may be the Reaſon of that Heavineſs in the Eye-lids and Eyes, after drinking hard or eating much.

The *FOURTH PAIR*, which are the ſmalleſt Nerves of any, derive their Origin from the poſterior Baſe of the *Teſtes*, and then making a long Courſe on the Side of the annular Protuberance, enter the *Dura Mater* a little farther back and outwards than the third Pair, to run alſo along the *Receptacula*, to paſs out at the *Foramina lacera*, and to be entirely ſpent on the *Muſculi trochleares*, or ſuperior oblique Muſcles of the Eyes. The rotatory Motions and the Advancement of the Eye-balls forward, by which Motions ſeveral of our Paſſions are expreſſed, principally depending on theſe Muſcles, the Nerves that ſerve them have got the Name of *PATHETICI.*

The *FIFTH PAIR* are large Nerves, riſing from the annular Proceſs, where the medullary Proceſſes of the *Cerebellum* join in the Formation of that *Tuber*, to enter the *Dura Mater* near the Point of the petrous Proceſs of the Temporal Bones, and then plunging into the *Receptacula* at the Side of the *Sella Turcica*, each becomes in appearance thicker, and goes out of the Skull in three great Branches.

The firſt Branch of the 5th is the *OPHTHALMICK*, which runs through the *Foramen lacerum* to the Orbit, having in its Paſſage thither a Connection with the 6th Pair: it is afterwards diſtributed to the Ball of the Eye with the 3d, to the Noſe, along with the Olfactory, which the Branch of the 5th that paſſes through the *Orbiter internus* Hole, joins in the Manner already mentioned in the Deſcription of the firſt Pair. This ophthalmic Branch likewiſe ſupplies the *Glandula lacrymalis*, Fat, Membranes, Muſcles and the Teguments of the Eye-lids, its longeſt fartheſt extended Branch paſſing through the *Foramen ſuperciliare* of the *Os Frontis* to be diſtributed to the Forehead.

The ſmall Fibres which this firſt Branch of the 5th and the third Pair of Nerves ſend to the Eye-ball, being ſituated on the optic Nerve, and after piercing the ſclerotick Coat running on the choroid Coat on the Outſide of the *Retina*

tina in their Courſe to the *Uvea* or *Iris*, may poſſibly be a Reaſon, why there is ſuch a Sympathy between the optic Nerve and the *Uvea*, that the *Uvea* contracts to leſſen the Pupil, and exclude too numerous Rays of Light; and this, with the Sympathy which muſt ariſe from ſome of the Nerves of the Membrane of the Noſtrils being derived from this firſt Branch of the 5th Pair of Nerves, may alſo be the Cauſe, why a ſtrong Irritation of too ſtrong Light upon the *Retina* may produce the ſame Effect, Sneezing, as when any tickling Subſtance is applied to the Membrane of the Noſe. In the Megrim all the Branches of this Nerve diſcover themſelves to be affected; for the Forehead is racked with Pain, the Eye-ball is pain'd, and feels as if it was ſqueezed, the Eye-lids ſhut convulſively, the Tears trickle down, and an uneaſy Heat is felt in the Noſe Hence we can underſtand, where external Medicines will have the beſt Effect, when applied to remove this Diſeaſe, to wit, to the Membrane of the Noſe and to the Forehead. Hence we can underſtand, why alternate Preſſure near the ſuperciliary Hole of the frontal Bone ſometimes gives immediate Relief in the Megrim.

The ſecond Branch of the 5th Pair of Nerves may be called *MAXILLARIS SUPERIOR*, from its ſerving principally the Parts of the upper Jaw. It goes out at the round Hole of the ſphenoid Bone, and ſends immediately one Branch in the Channel on the Top of the *Antrum maxillare*, the Membrane of which and the ſuperior Teeth are ſupplied by it in its Paſſage. As it is about to go out at the *Orbiter externus* Hole, it ſends a Nerve through the Subſtance of the *Os maxillare*, to come out at *Steno*'s Duct, to be diſtributed to the anterior Part of the Palate; and what remains of it eſcaping at the *Orbiter externus* Hole, divides into a great many Branches, that ſupply the Cheek, upper Lip and Noſtril. The next conſiderable Branch of the ſuperior maxillary Nerve is ſent into the Noſe by the Hole common to the Palate and ſphenoidal Bone, and the remaining Part of this Nerve runs in the *Palato-maxillaris* Canal, giving off Branches to the Temples and Pterygoid Muſcles, and comes at laſt into the Palate to be loſt. Hence the Ach in the Teeth of the upper Jaw occaſions a gnawing Pain deep ſeated in the Bones of the Face, with a Swelling in the Eye-lids, Cheek, Noſe and upper Lip; and on the other hand, an Inflammation in theſe Parts is often attended with ſharp Pain in the Teeth. Hence an Obſtruction in the Duct of the maxillary Sinus, which obliges the Liquor ſecreted there to find out a preternatural Rout for itſelf, as I have ſeen more than once, may be occaſioned by the Pain of the Teeth.

The third or *MAXILLARIS INFERIOR* Branch of the fifth Pair going out at the oval Hole of the ſphenoid Bone, ſerves the Muſcles of the lower Jaw, and the Muſcles ſituated between the *Os hyoides* and *Jaw*; all the ſalivary Glands, the *Amygdalæ* and the external Ear have Branches from it; it has a large Branch loſt in the Tongue, and ſends another through the Canal in the Subſtance of the lower Jaw, to ſerve all the Teeth there, and to come out at the Hole in the anterior Part of the Jaw, to be loſt in the Chin and Under-lip. Hence a convulſive Contraction of the Muſcles of the lower Jaw, or the Mouth's being involuntarly ſhut, a great Flow of Spittle or Salivation, a Pain in the Ear eſpecially in Deglutition, and a Swelling all about the Throat, are natural Conſequences of a violent Irritation of the Nerves of the lower Teeth in the Tooth-ach; and Pain in the Teeth and Ear is as natural a Conſequence of an *Angina*. Hence alternate Preſſure on the Chin may ſometimes relieve the Violence of a Tooth-ach. Hence deſtroying the Nerves of a Tooth by actual or potential Cauteries, or pulling a carious Tooth, ſo often removes immediately all theſe Symptoms. Hence no Cure is to be found for ſome Ulcers in the upper or lower Jaw, but by drawing a Tooth.

The *SIXTH PAIR*, which is the ſmalleſt except the fourth, riſes from the Forepart of the *Corpora pyramidalia*, and entring the *Dura Mater* ſome way behind the Extremities of the poſterior clinoid Proceſſes of the ſphenoid Bone, have a long Courſe below that Membrane, and within the *Receptacula* at the Side of the *Sella Turcica*, to go out at the *Foramina lacera* into the Orbit, to be loſt in the Abductor-muſcle of the Eye. In this Paſſage each of them lies very contiguous to the internal carotid Artery, and to the ophthalmick Branch of the fifth Pair of Nerves. At the ſame Place where they are contiguous to the Carotid, a Nerve, either, according to the general Deſcription of Anatomiſts, goes from each of them in an uncommon way (that is the Angle is obtuſe beyond where it riſes) to deſcend with the Artery, and to form the Beginning of the *intercoſtal* Nerve; or, according to other Authors, this Nerve comes up from the great *Ganglion* of the *Intercoſtal* to be joined to the ſixth here.

The Arguments for this latter Opinion are, That according to the common Opinion, this Beginning of the *intercoſtal* Nerve, as 'tis called, would riſe in a Manner not ſo ordinary in Nerves. In the next Place it is obſerved, that the ſixth Pair is larger nearer to the Orbit, than it is before it comes to the Place where this Nerve is ſaid to go off; and therefore it is more probable, that it receives an Addition there rather than gives off a Branch. *Laſtly*, It is found, that upon cutting the *intercoſtal* Nerves of living Animals, the Eyes plainly were affected, they loſt their bright Water, the Gum, or Gore, as we call it, was ſeparated in greater Quantity, the Pupil was more contracted, the cartilaginous Membrane at the internal Canthus came more over the Eye, and the Eye-ball itſelf was diminiſhed.

To this it is anſwered in Defence of the more common Doctrine, that other Branches of Nerves go off in a reflected Way as well as this does, ſuppoſing it to be the Beginning of the Intercoſtal, and that the Reflection would rather be greater, if it is thought to come up from the Intercoſtal to the ſixth. 2*dly*, That Nerves enlarge ſometimes where there is no Addition made to them, as in the Inſtance already mentioned of the Trunk of the fifth Pai while below the *Dura Mater*. 3*dly*, That the Experiments on living Animals ſhew indeed that the Eyes are affected upon cutting the intercoſtal Nerve, but not in the Way mig

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have been expected, if the *Intercoſtal* furniſhes ſuch a Share of the Nerve that goes to the *Abductor* Muſcle of the Eye; for it might have been thought, that this Muſcle would have been ſo much weakned immediately upon cutting the *Intercoſtal*, as its Antagoniſt the *Adductor* would have greatly prevailed over it, and have turned the Eye ſtrongly in towards the Noſe, which is not ſaid to be a Conſequence of this Experiment. So that the Arguments are ſtill equivocal, and more Obſervations and Experiments muſt be made before it can be determined with Certainty, whether the ſixth Pair gives or receives a Branch here. In the mean time I ſhall continue to ſpeak about the Origin of the *Intercoſtal* with the common Herd of Anatomiſts.

At this ſame Place where the Intercoſtal begins, the fifth Pair is contiguous and adherent to the ſixth; and it is generally ſaid, that the ophthalmic Branch of the fifth gives a Branch or two to the Beginning of the Intercoſtal, or receives ſuch from it. Others deny any ſuch Communication between them, and thoſe who affirm the Communication confeſs, that in ſome Subjects they could not ſee it. After examining the Nerves here in a great many Subjects, I cannot determine whether or not there are nervous Filaments going from the one to the other. Sometimes I thought I traced them evidently; at other times I obſerved what I diſſected for nervous Filaments, to be no other than collapſed cellular Subſtance; and in all the Subjects where I had puſhed an Injection ſucceſsfully into the very ſmall Arteries, I could only obſerve a *Plexus*

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of Veſſels connecting the one to the other. In any of theſe Ways however there is as much Connection, as we are aſſured from many Experiments and Obſervations on other Nerves, is ſufficient to make a very great Sympathy among the Nerves here. Poſſibly the Appearances in the Eyes of Dogs, whoſe intercoſtal Nerves were cut, might be owing to this Sympathy.

The *SEVENTH PAIR* comes out from the lateral Part of the *annular Proceſs*, behind where the medullary Proceſſes of the *Cerebellum* are joined to that *Tuber*, and, being accompanied with a larger Artery than moſt other Nerves, enters the *internal Meatus auditorius*, where ſoon the two great Pacquets of Fibres, of which it appeared to conſiſt within the Skull, ſeparate from each other; one of them enters by ſeveral ſmall Holes into the *Veſtible*, *Cochlea* and *ſemicircular Canals*, is ſtretched on this inner *Camera* of the Ear in a very ſoft pulpy Subſtance; and being never ſeen in the Form of a firm Cord, ſuch as the other Packet of this Nerve and moſt other Nerves become, is called *PORTIO MOLLIS* of the auditory Nerve.

The other Part of this ſeventh Pair paſſes through *Galen's Foramen cæcum* or *Fallopius's Aqueduct* in its crooked Paſſage by the Side of the *Tympanum*, in which Paſſage a Nerve ſent from the lingual Branch of the inferior maxillary Nerve, along the outſide of the *Tuba Euſtachiana*, and croſs the Cavity of the *Tympanum*, where it has the Name of *Chorda Tympani*, is commonly ſaid to be joined to it. The very acute Angle which this Nerve makes with the fifth, or the ſudden violent Reflexion it would ſuffer, on the Suppoſition of its coming from the fifth to the ſeventh, whereas ſuppoſing its Courſe from the ſeventh to the fifth, its Courſe would be more in the ordinary Way, has made ſome ſay, that this *Chorda tympani* ſhould be eſteemed a Branch of the ſeventh Pair going to join the fifth. This ſame ſmaller Packet of the ſeventh gives Branches to the Muſcles of the *Malleus* and to the *Dura Mater*, while it paſſes through the bony crooked Canal, and at laſt comes out in a firm Cord named *PORTIO DURA*, at the Extremity of this Canal, between the *ſtyloid* and *maſtoid* Proceſſes of the temporal Bone, giving immediately Filaments to the little oblique Muſcles of the Head, and to thoſe that riſe from the ſtyloid Proceſs. It then pierces through the parotid Gland, and divides into a great many Branches, which are diſperſed in the Muſcles and Teguments that cover all the Side of the ſuperior Part of the Neck, the whole Face and *Cranium*, as far back as the Temples, including a conſiderable Part of the external Ear. Its Branches having thus a conſiderable Connection with all the three Branches of the fifth Pair, and with the ſecond cervical, occaſions a conſiderable Sympathy of theſe Nerves with it. Hence in the Tooth-ach, the Pain is ſometimes very little in the affected Tooth, compared to what it is all along the Side of the Head and in the Ear. Hence probably the Relief of the Tooth-ach by Bliſters applied behind the Ear, or by a hot Iron touching the *Antihelix* of the Ear. By this Communication or Connexion poſſibly too it is, that a vibrating String held between one's Teeth, gives him a ſtrong Idea of its Sound which no other can hear. Perhaps too the Diſtribution of this Nerve occaſions the Head to be ſo quickly turned upon the Impreſſion of Sound on our Ears.

The *EIGHTH PAIR* of Nerves riſe from the lateral Baſe of the *Corpora olivaria* in diſgregated Fibres, and as they are entring the anterior internal Part of the Hole, common to the *Os Occipitis* and *Temporum*, each is joined by a Nerve which aſcends within the *Dura Mater* from the 10th of the Head, the firſt and ſecond cervical, and ſometimes from inferior Nerves: This every Body knows has the Name of the *NERVUS ACCESSORIUS*. When the two get out of the Skull, the *Acceſſorius* ſeparates from the eighth, and deſcending obliquely outwards, paſſes through the *Sternomaſtoideus* Muſcle, to which it gives Branches to be loſt in the *Trapezius* and *Rhomboid* Muſcles of the *Scapula*. In this Courſe it is generally more or leſs joined by the ſecond cervical Nerve.

The large *eighth Pair* ſoon after its Exit gives Nerves to the Tongue, *Larynx*, *Pharynx* and *Ganglion* of the *Intercoſtal* Nerve, and being disjoined from the 9th and Intercoſtal, to which it adheres cloſely ſome way, runs ſtraight down the Neck behind the internal jugular Vein, and at the interior Side of the internal carotid Artery. As it is about to enter the *Thorax*, a large Nerve goes off from the eighth of each Side: This Branch of the right Side turns round from the anterior to the poſterior Part of the ſubclavian Artery, while the Branch of the left Side turns round the great

Curve of the *Aorta*, both of them mounting up again at the Side of the *OEſophagus*, to which they give Branches, are loſt at laſt in the *Larynx*. Theſe are called the *RECURRENT* Nerves, which we are deſired to ſhun in the Operation of *Bronchotomy*, tho' their deep Situation protects them ſufficiently. The Muſcles of the *Larynx* being in a good meaſure ſupplied with Nerves from the Recurrents, it is to be expected, that the cutting of them will greatly weaken the Voice, tho' it will not be entirely loſt, ſo long as the ſuperior Branches of the eighth Pair are entire.

At or near the Place where the recurrent Nerves go off from the eighth Pair, or frequently from the Recurrents themſelves, Nerves go off to the *Pericardium*, and to join with the Branches of the Intercoſtal that are diſtributed to the Heart.

After theſe Branches are ſent off, the *Par vagum* on each Side deſcends behind the great Branch of the *Trachea* and gives numerous Filaments to the Lungs in going to the *OEſophagus*. The one of the left Side running on the Forepart of the *OEſophagus*, communicates by ſeveral Branches with the right one in its Deſcent to be diſtributed to the Stomach: The right one gets behind the *OEſophagus*, where it ſplits and rejoins ſeveral Times before it arrives at the Stomach, to which it ſends Nerves; and then being joined by a Branch from the left Trunk, they run towards the cæliac Artery, there to join into the great *ſemilunar Ganglion* formed by the two Intercoſtals.

From the Diſtribution of this *Par vagum*, we may learn how tickling the *Fauces* with a

Feather or any ſuch Subſtance, excites a Nauſea and Inclination to vomit. Why coughing occaſions vomiting, or vomiting raiſes a Cough. Hence we ſee how the nervous *Aſthma* and the *Tuſſis convulſiva*, Kinkcough, are attended with a ſtraitning of the *Glottis*. How Food ill to digeſt brings on the *Aſthma* on weakly People, and why *Emetics* have frequently cured the *Aſthma* very ſpeedily. How the ſuperior Orifice of the Stomach is ſo ſenſible as to be looked on as the Seat of the Soul by ſome. How People ſubject to Diſtenſions of the Stomach have ſo often the Senſations of Balls in their Breaſt or Throats. Why the *Globus hyſtericus* is ſo often attended with a violent Strangulation at the *Glottis*. The Sympathy among the Branches of theſe Nerves will lead us to underſtand theſe and ſeveral other Phænomena.

The *NINTH PAIR* of Nerves comes from the inferior Part of the *Corpora pyramidalia*, to go out of the Skull at their proper Holes of the occipital Bones. After their Egreſs they adhere for ſome way firmly to the 8th and Intercoſtal, and then ſending a Branch that in many Subjects is joined with Branches of the firſt and ſecond cervical Nerves, to be diſtributed to the Thyroid Gland and Muſcles on the Fore-part of the *Trachea Arteria*, the 9th is loſt in the Muſcles and Subſtance of the Tongue. Some have thought this Nerve, and others have eſteemed the third Branch of the fifth Pair of Nerves to be the proper guſtatory Nerve. I know no Obſervations or Experiments to prove either Opinion, or to determine that both the Nerves may not ſerve for

Taſting, and for the Motion of the Tongue.

The *TENTH PAIR* riſes from the Sides of the *Medulla ſpinalis*, to go out between the *Os Occipitis* and *firſt Vertebra* of the Neck. After each of them gives a Branch to the great Ganglion of the Intercoſtal Nerve, they are diſtributed to the oblique Muſcles, and to ſome of the Extenſors of the Head. Whether the Name of the tenth of the Head, or of the firſt Vertebral, ought to be given to this Nerve, is of no ſuch Conſequence as to deſerve a Debate.

In the Deſcription of the ſixth Pair, I ſaid that I would uſe the way of ſpeaking which moſt Anatomiſts have, to wit, I would ſay that the Beginning of the Intercoſtal Nerve comes out of the Skull, and therefore ſhall here ſubjoin a curſory Deſcription of this Nerve to thoſe of the Head, notwithſtanding its much larger Part is compoſed of Nerves coming out from the *Medulla ſpinalis*. There is no greater Incongruity in Point of Method to ſay, that a Nerve one is deſcribing receives Additions from Nerves that have not been deſcribed, than it is to repeat in the Deſcription of a great many Nerves, that each of them gives Branches to form a Nerve which we are ignorant of, which is all the Difference between deſcribing the Intercoſtal before or after the ſpinal Nerves.

The Branch reflected from the ſixth Pair, joined poſſibly by ſome Filaments of the *Ophthalmic* Branch of the fifth, runs along with the internal Carotid thro' the crooked Canal formed for this Artery in the *temporal Bone*, where the little Nerve is very ſoft and pappy, and in ſeveral Subjects divides and unites again before it comes out of the Skull. As ſoon as the Nerve eſcapes out of this bony Canal it is connected a little way with the eighth and ninth, then ſeparating from them, after ſeeming to receive additional Nerves from them, it forms a *large Ganglion*, into which Branches from the tenth of the Head, and from the firſt and ſecond cervical enter. From this Ganglion the Nerves come out again ſmall to run down the Neck along with the carotid Artery, communicating by Branches with the cervical Nerves, and giving Nerves to the Muſcles that bend the Head and Neck. As the *Intercoſtal* is about to enter the *Thorax*, it forms another Ganglion from which Nerves are ſent to the Trachea and to the Heart; theſe deſigned for the Heart joining with the Branches of the eighth, and paſſing between the two great Arteries and the Auricles to the Subſtance of that Muſcle. The Intercoſtal after this being compoſed of two Branches, one going behind, and the other running over the anterior Part of the Subclavian Artery, forms a new Ganglion where the two Branches unite below that Artery, and then deſcending along the Sides of the *Vertebræ* of the *Thorax*, receives Branches from each of the dorſal Nerves, which Branches appearing to come out between the Ribs, have given the Name of Intercoſtal to the whole Nerve. Where the Addition is made to it from the fifth dorſal Nerve, a Branch goes off obliquely forwards, which being joined by other ſuch Branches from the ſixth, ſeventh, eighth and ninth dorſal, an anterior Trunk is formed ed that paſſes between the Fibres of the *Appendix muſculoſa* of the Diaphragm to form along with the other Intercoſtal and the Branches of the eighth Pair, a large ſemilunar Ganglion ſituated between the cæliac and ſuperior meſenteric Arteries; the Roots of which are, as it were, involved in a ſort of nervous Net-work of this Ganglion, from which a great Number of very ſmall nervous Threads run out to be extended on the Surface of all the Branches of theſe two Arteries, ſo as to be eaſily ſeen when any of the Arteries are ſtretched, but not to be diſſected off from them; and thus the *Liver*, *Gall-Bladder*, *Duodenum*, *Pancreas*, *Spleen*, *Jejunum*, *Ilium*, and a large Share of the *Colon* have their Nerves ſent from this great *ſolar Ganglion* or *Plexus*.

Several Fibres of this Ganglion running down upon the Aorta, meet with other Nerves ſent from the poſterior Trunk of the Intercoſtal, which continues its Courſe along the Sides of the *Vertebræ*, they ſupply the *Glandulæ renales*, Kidneys and *Teſtes* in Men or *Ovaria* in Women; and then they form a Net-work upon the inferior meſenteric Artery where the Nerves of the two Sides meet, and accompany the Branches of this Artery to the Part of the *Colon* that lies in the left Side of the Belly, and to the *Rectum* as far down as the lower Part of the *Pelvis*.

The Intercoſtal continuing down by the Side of the *Vertebræ* of the Loins, is joined by Nerves coming from between theſe *Vertebræ*, and ſends Nerves to the Organs of Generation and others in the *Pelvis*, being even joined with thoſe that are ſent to the inferior Extremities.

The almoſt univerſal Connection and Communication this Nerve has with the other Nerves of the Body, may lead us to underſtand a great many *Phænomena*, where one otherwiſe would be greatly ſurprized at the Sympathy to be obſerved among the Parts of the Body. One who knows the Courſe of this Nerve will readily underſtand why a Stone in the Kidneys, or Ureters, or any other Cauſe irritating thoſe Organs, ſhould ſo much more frequently bring on Vomiting and other Diſorders of the Stomach, than the Stone or any other ſtimulating Cauſe in the Bladder does. The Obſtructions of the *Menſes* will hence appear capable of occaſioning Strangulations, Belching, Colicks, Stomach-aches, and even Convulſions in the Extremities may be owing to ſuch Obſtructions, or to any violent Irritations of the Stomach or Guts. With a View to theſe Communications, I have frequently applied Veſicatories from the Ears to the Clavicles of Children labouring under the *Tuſſis convulſiva* with obſervable good Succeſs.

The *ſpinal* Nerves riſe generally by a Number of diſgregated Fibres from both the anterior and poſterior Part of the *Medulla ſpinalis*, and ſoon after form a little Knot or Ganglion where they get on their firm Coats, and are extended into firm Cords. They are diſtinguiſhed by Numbers, according to the *Vertebræ* from between which they come out, the ſuperior of the two Bones forming the Hole thro' which they paſs, being the one from which the Number is applied to each Nerve.

There are generally ſaid to be *thirty Pair* of them, ſeven of which come out between the *Vertebræ* of the *Neck*, twelve between thoſe of the *Back*, five from the *Loins*, and ſix from the *Os ſacrum*.

The *FIRST CERVICAL* Pair of Nerves comes out between the firſt and ſecond *Vertebræ* of the Neck, and having given Branches to join with the tenth Pair of the Head, the ſecond Cervical and Intercoſtal, and to ſerve the Muſcles that bend the Neck, it ſends its largeſt Branches backwards to the extenſor Muſcles of the Head and Neck; ſome of which piercing thro' theſe Muſcles run up on the *Occiput* to be loſt in the Teguments there; and many Fibres of it advance ſo far forward, as to be connected with the *Fibrillæ* of the firſt Branch of the fifth Pair of the Head, and of the *Portio Dura* of the *Auditory Nerve*. Hence poſſibly it is that a *Clavus hyſtericus* ſhall ſuddenly change from the Fore-head to a violent Pain and Spaſm in the Back-part of the Head and Neck.

The *SECOND CERVICAL* is ſoon joined by ſome Branches to the ninth of the Head and Intercoſtal, and to the firſt and third of the Neck, then has a large Branch that comes out at the exterior Edge of the *Sternomaſtoideus* Muſcle, where it joins with the *Acceſſorius* of the eighth Pair, and then is diſtributed to the *Platyſma Myoides*, Teguments of the Side of the Neck and Head, parotid Gland and external Ear, being connected to the *Portio Dura* of the Auditory Nerve and to the firſt cervical. The Remainder of this ſecond Cervical is ſpent on the *Levator ſcapulæ*, and the Extenſors of the Neck and Head. Generally a large Branch is here ſent off to join the *Acceſſorius* of the eighth Pair, near the ſuperior Angle of the *Scapula.*

To the Irritation of the Branches of this Nerve, it probably is, that in an Inflammation of the parotid Gland, the Neck is pain'd as far down as the Clavicle, the Head is drawn towards the Shoulder of the affected Side, and the Chin is turned to the other Side. In opening the external Jugular-Vein, no Operator can promiſe not to touch ſome of the cutaneous Branches of this Nerve with the Edge of the Lancet, which occaſions a ſharp pricking Pain in the mean Time, and a Numneſs of the Skin near the Orifice for ſome Time after.

The *THIRD PAIR* of the Neck paſſes out between the third and fourth cervical *Vertebræ*, having immediately a Communication with the ſecond, and ſending down a Branch, which being joined by a Branch from the fourth cervical forms the *PHRENIC* Nerve. This deſceding enters the *Thorax* between the ſubclavian Vein and Artery, and then being received into a Groove formed for it in the *Pericardium*, it has its Courſe along this *Capſula* of the Heart, till it is loſt in the middle Part of the Diaphragm. The right Phrenic has a pretty ſtreight Courſe, but the left one is obliged to make a conſiderable Turn outwards, to go over the prominent Part of the *Pericardium* where the Point of the Heart is lodged. Hence in violent Palpitations of the Heart, a pungent acute Pain is felt near the left Orifice of the Stomach.

The other Branches of the third cervical Nerv

Nerve are diſtributed to the Muſcles and Teguments at the inferior Part of the Neck and Top of the Shoulder. No Wonder then that an Inflammation of the Liver or Spleen, an Abſceſs in the Lungs adhering to the Diaphragm, or any other Cauſe capable of irritating the Diaphragm, ſhould be attended with a ſharp Pain in the Top of the Shoulder, as well as Wounds, Ulcers, *&c.* of this Muſcle itſelf. If the Irritation of this Muſcle is very violent, it may occaſion that convulſive Contraction of the Diaphragm which is called a Hiccough, and therefore a Hiccough in an Inflammation of the Liver has been juſtly declared to be an ill Symptom.

The Irritation of the thoracic Nerves ſo as to produce ſneezing, may ſometimes free the phrenic Nerves from any Spaſm they occaſion; ſo that ſneezing ſometimes takes away the Hiccough, and a Derivation of the Fluid of the Nerves any other way may do the ſame Thing: Or the Hiccough may alſo be ſometimes cured by a Surprize, or any other ſtrong Application of the Mind in thinking or in diſtinguiſhing Objects.

The *FOURTH CERVICAL* Nerve, after ſending off that Branch which joins with the third to form the Phrenic, and beſtowing Twigs on the Muſcles and Glands of the Neck runs to the Arm-Pit, where it meets with the *FIFTH*, *SIXTH* and *SEVENTH* Cervicals' and *FIRST DORSAL*, that eſcape in the Interſtices of the *Muſculi ſcaleni*, to come at the Arm-Pit where they join, ſeparate, and re-join in a way ſcarce to be rightly expreſſed in Words; and after giving ſeveral conſiderable Nerves to the Muſcles and Teguments which cover the *Thorax*, they divide into ſeveral Branches to be diſtributed to all the Parts of the ſuperior Extremity. Seven of theſe Branches I ſhall deſcribe under particular Names.

1. *CUTANEUS* runs down the Fore-part of the Arm near the Skin to which it gives off Branches, and then divides on the Fore-arm into ſeveral Nerves, which ſupply the Teguments there and on the Palm of the Hand. In opening the Cephalic Vein of the Arm at the ordinary Place, the ſame Symptoms are produced, as I mentioned to be done in opening the external Jugular-Vein, and by the like Cauſe, to wit, the hurting a Branch of this cutaneous Nerve with the Lancet.

2. *MUSCULO-CUTANEUS* or *perforans Caſſerii* paſſes thro' the *coraco-brachialis* Muſcle, and, after ſupplying the *biceps flexor cubiti* and *brachiæus internus*, is ſpent on the Teguments on the out-ſide of the Fore-arm and Back of the Hand.

3. *MUSCULARIS* has a ſpiral Courſe from the *Axilla* under the *Os humeri*, and backward to the external Part of that Bone, ſupplying by the Way the extenſor Muſcles of the Fore-arm, to which it runs between the two *brachiæi* Muſcles, to be chiefly beſtowed on the Muſcles that extend the Wriſt and Fingers; ſome of its Branches going likewiſe to the Flexors, and others ſerving the Skin on the out-ſide of the Fore-arm, the Extremity of it deſcends along the *Radius* to the Back of the Hand, in which, and in the back convex Part

of the Thumb and three large Fingers it terminates.

4. *ULNARIS* is extended along the In-ſide of the Arm, to give Nerves to the Muſcles that extend the Fore-arm and to the Teguments of the Elbow; towards the lower Part of the Arm it ſlants a little backward to come at the Groove behind the internal Condyle of the *Os humeri*, thro' which it runs to the *Ulna*; in its Courſe along this Bone it ſerves the neighbouring Muſcles and Teguments; and as it comes near the Wriſt, it detaches a Branch obliquely over the *Ulna* to the Back of the Hand, to be loſt in the convex Part of ſeveral Fingers. The larger Part of the Nerve goes ſtraight forward to the internal Side of the *Os piſiforme* of the Wriſt; where it ſends off a Branch which ſinks under the large Tendons in the Palm, to go croſs to the other Side of the Wriſt, ſerving the *muſculi lumbricales* and *interoſſei*, and at laſt terminating in the ſhort Muſcles of the Thumb and Fore-finger. What remains of the ulnar Nerve, after ſupplying the ſhort Muſcles of the Little-finger, divides into three Branches; whereof two are extended along the Sides of the Sheath of the Tendons of the Flexors of the Little-finger, to furniſh the concave Side of that Finger; and the third Branch is diſpoſed in the ſame Way upon the Side of the Ring-finger next to the Little finger.

When we lean or preſs on the internal Condyle of the *Os humeri*, the Numneſs and Prickling we frequently feel point out the Courſe of this Nerve; I have ſeen a Weakneſs and Atrophy in the Parts which I mentioned this Nerve to be ſent to, after a Wound in the internal inferior Part of the Arm.

5. *RADIALIS* accompanies the humeral Artery to the bending of the Elbow, ſerving the Flexors of the Cubit in its Way; then, after giving large Nerves to the Muſcles on the Fore-part of the Fore-arm, it continues its Courſe near to the *Radius*, beſtowing Branches on the circumjacent Muſcles. Near the Wriſt it gives off a Nerve which is diſtributed to the Back of the Hand, and the convex Part of the Thumb, and ſeveral of the Fingers. The larger Part of this Nerve paſſing behind the annular Ligament of the Wriſt gives Nerves to the ſhort Muſcles of the Thumb, and afterwards ſends a Branch along each Side of the Sheath of the Tendons of the Flexors of the Thumb, Fore-finger, Middle-finger, and one Branch to the Side of the Ring-finger next to the Middle, to be loſt on the concave Side of thoſe Fingers.

The Manner of theſe Nerves of the Fingers, both from the *Ulnar* and *Radial* going off, is that a ſingle Branch is ſent from the Trunk to the Side of the Thumb and Little-finger fartheſt from the other Fingers; and all the reſt are ſupplied by a Trunk of a Nerve, which ſplits into two ſome way before it comes as far as the End of the *Metacarpus*, to run along the Sides of different Fingers that are neareſt to each other.

It might have been obſerved, that in deſcribing the poſterior Branches of the *ulnar* and *radial Nerve*, I did not mention the particular Fingers, to the convex Part of which, they were diſtributed. My Reaſon for this Omiſſion is the Uncertainty of their Diſtribution; for tho' ſometimes theſe poſterior Branches go to the ſame Fingers, to the concave Part of which their anterior Branches are ſent, yet frequently they are diſtributed otherwiſe, and I ought to obſerve that the muſcular Nerve has not always that Termination in the Back of the Hand which I mentioned.

6. *ARTICULARIS* ſinks downwards at the *Axilla*, to get below the Neck of the ſuperior Head of the *Os humeri*, and to mount again at the Back-part of it; ſo that it almoſt ſurrounds the Articulation, and is diſtributed to the Muſcles that draw the Arm back and raiſe it up.

7. *SCAPULARIS* runs ſtraight to the *Cavitas ſemilunata* of the upper *Coſta* of the *Scapula*, which is made a Hole in the recent Subject, a Ligament being extended from one Angle of the Bone to the other, giving Nerves in its Way to the Muſcles of the *Scapula*. When it has paſſed this Hole it ſupplies the *Supraſpinatus* Muſcle, and then deſcending at the anterior Root of the *Spine* of the *Scapula*, it is loſt in the other Muſcles that lye on the *Dorſum* of the *Scapula*.

The Situation of theſe brachial Nerves in the *Axilla*, may let us ſee how a Weakneſs and Atrophy may be brought on the Arms by long continued Preſſure of Crutches, or ſuch other hard Subſtances on this Part; and the Courſe of them from the Neck to the Arm may teach us how much better Effects, Veſicatories or ſtimulating nervous Medicines would have, when applied to the Skin, covering the tranſverſe Proceſſes of the *Vertebræ*, or at the *Axilla*, than when they are put between the Shoulders, or upon the ſpinal Proceſſes in Convulſions or Palſies of the ſuperior Extremities, where a Stimulus is required.

The *TWELVE DORSAL* Nerves of each Side as ſoon as they eſcape from between the *Vertebræ*, ſend a Branch forward to join the Intercoſtal, by which a Communication is made among them all, and they ſoon likewiſe give Branches backwards to the Muſcles that raiſe the Trunk of the Body, their principal Trunk being extended outwards to come at the Furrow in the lower Edge of each Rib, in which they run toward the anterior Part of the *Thorax*, between the internal and external intercoſtal Muſcles, giving off Branches in their Courſe to the Muſcles and Teguments of the *Thorax*.

The *FIRST* Dorſal has already been ſaid to have this Particular in it, that it contributes to form the brachial Nerves, and that the two Branches of the Intercoſtal, which come down to the *Thorax*, form a conſiderable Ganglion with it.

The *SIX* inferior dorſal Nerves give Branches to the Diaphragm and abdominal Muſcles.

The *TWELFTH* joins with the firſt Lumbar, and beſtows Nerves on the *Muſculus quadratus Lumborum* and *Iliacus internus*.

May not the Communications of all theſe Nerves be one Reaſon of the Parts they ſerve acting ſo uniformly and conjunctly in Reſpiration, and conſpiring together in the convulſive Motions of Coughing, Sneezing, *&c*?

The twitching Spaſms that happen ſometimes in different Parts of the Muſcles of the *Abdomen*, by any Irritation on the Branches of the lower dorſal Nerves are in Danger of occaſioning a Miſtake in Practice, by their Reſemblance to the Colick, *Nephritis*, &c. The Communications of theſe lower ones with the Intercoſtals may ſerve to explain the violent Effort of the abdominal Muſcles in a *Teneſmus* and in Child-bearing.

As the Intercoſtal is ſo much larger in the *Thorax* than any where elſe, and ſeems to diminiſh gradually as it aſcends and deſcends, there is ſome Suſpicion that the Trunk of it is here, from which the ſuperior and inferior Parts are ſent as Branches.

The *FIVE LUMBAR* Nerves on each Side communicate with the Intercoſtal and with each other, and give poſterior Branches to the Loins.

The *FIRST* commuicates with the laſt dorſal, ſends Branches to the abdominal Muſcles, to the *Pſoas* and *Iliacus*, and to the Teguments and Muſcles on the anterior Part of the Thigh; while its principal Branch joins with other Nerves to form the crural Nerve.

The *SECOND LUMBAR* Nerve paſſes through the *Pſoas Muſcle*, and is diſtributed nearly in the ſame Way as the former, as is alſo the *THIRD*.

Branches of the *firſt*, *ſecond* and *third* make up one Trunk, which runs along the anterior Part of the *Pelvis*, and paſſing in the Notch at the anterior Part of the great Hole common to the *Os Pubis* and *Iſchium*, is ſpent on the *Adductor* Muſcles and the Teguments on the Inſide

ſide of the Thigh. This Nerve is called the *OBTURATOR* or *POSTERIOR CRURAL NERVE.*

By united Branches from the *firſt*, *ſecond*, *third* and *fourth* lumbar Nerves, a Nerve is formed that runs along the *Pſoas* Muſcle, to eſcape with the external Iliac Veſſels out of the *Abdomen*, below the tendinous Arcade of the external oblique Muſcle. This Nerve, which is named the *ANTERIOR CRURAL*, is diſtributed principally to the Muſcles and Teguments on the anterior Part of the Thigh. A Branch however of this Nerve runs down the Inſide of the Leg to the ſuperior Part of the Foot keeping near to the *Vena ſaphæna*; in opening of which with a Lancet at the Ancle, the Nerve is ſometimes hurt, and occaſions ſharp Pain at the Time of the Operation, and Numneſs afterwards.

The Remainder of the fourth Lumbar and the fifth joins in compoſing the largeſt Nerve of the Body, which is ſoon to be deſcribed.

Whoever attends to the Courſe of theſe lumbar Nerves, and of the ſpermatic Veſſels and Nerves upon the *Pſoas* Muſcle with the oblique Paſſage of the *Ureter* over that Muſcle, will not be ſurprized, that when a Stone is paſſing in this Canal, or even when it is inflamed, the Trunk of the Body cannot be raiſed erect without great Pain; or that the Skin of the Thigh becomes more inſenſible, and the Thigh is drawn forward, and that the Teſticle often is drawn convulſively towards the Ring of the abdominal Muſcles.

The *SIX PAIR* of the *OS SACRUM* conſiſt each of ſmall poſterior Branches ſent to the Hips, and of large anterior Branches.

The *firſt*, *ſecond* and *third*, after coming through the three ſuperior Holes of the *Os ſacrum*, join together and with the fourth and fifth of the Loins, to form the largeſt Nerve by much of the Body, which is well known by the Name of *SCIATIC* or *ISCHIATIC* Nerve: This, after ſending large Nerves to the different Parts of the *Pelvis*, and to the external Parts of Generation and the *Podex*, as alſo to the Muſcles of the Hips, paſſes behind the great *Tuber* of the *Os Iſchium*, and then over the *Quadrigemini* Muſcles to run down near to the Bone of the Thigh at its poſterior Part, giving off Nerves to the neighbouring Muſcles and Teguments. Some Way above the Ham, where it has the Name of the *Poplitæus* Nerve, it ſends off a large Branch that paſſes over the *Fibula*, and ſinking in among the Muſcles on the anterior external Part of the Leg, runs down to the Foot, to be loſt in the ſuperior Part of the larger Toes, ſupplying the neighbouring Muſcles and Teguments every where in its Paſſage. The larger Branch of the *Sciatic*, after giving Branches to the Muſcles and Teguments about the Ham and Knee, and ſending a large cutaneous Nerve down the Calf of the Leg, to be loſt at laſt in the exterior Side of the Foot and ſuperior Part of the leſſer Toes, ſinks below the *Gemellus* Muſcle, and diſtributes Nerves to the Muſcles on the Back of the Leg; among which it continues its Courſe, till paſſing behind the internal *Malleolus* and in the internal Hollow of the *Os Calcis*, it divides into the two plantar Nerves. The internal of which is diſtributed to the

Toes, in the ſame Manner as the radial Nerve of the Hand ſerves the concave Side of the Thumb and Fingers, and the external Plantar is divided and diſtributed to the Sole of the Foot and Toes, nearly as the ulnar Nerve is in the Palm of the Hand and in the concave Part of the Fingers.

By applying what was ſaid of the Nerves in general to the particular Diſtribution of the Nerves of the inferior Extremities, we may ſee how People with fractured Legs, eſpecially where there are Splinters, ſhould be ſo ſubject to convulſive Startings of the fractured Member, and why upon tying the Blood-veſſels in an Amputation of the Leg, the Patients ſhould ſometimes complain of violent Pain in their Toes; why ſuch Patients ſhould alſo be troubled with Startings, or why, for a conſiderable Time after the Amputation of the diſeaſed Limb, when the Suppuration is well advanced, they ſhould complain of Pain in the Sore which occaſioned the Amputation.

The *FOURTH* Nerve of the *Os ſacrum*, which with the two following is much ſmaller than the three ſuperior, ſoon is loſt in the *Veſica urinaria* and *Inteſtinum rectum*.

The *FIFTH* comes forward between the Extremity of the *Os ſacrum* and *Coccygis*, to be diſtributed principally to the *Levatores Ani*.

The *SIXTH* advances forward below the broad Shoulders of the firſt Bone of the *Os Coccygis*, and is loſt in the *Sphincter Ani* and Teguments covering it.

The Branches of the four laſt cervical Nerves, and of the firſt dorſal, which are beſtowed on the ſuperior Extremity, and the two

Crurals, with the Sciatic, which are diſtributed to the inferior Extremities, are much larger proportionally to the Parts they ſerve, than the Nerves of the Trunk of the Body, and eſpecially of the *Viſcera* are; and for a very good Reaſon, that in the moſt common neceſſary Actions of Life a ſufficient Quantity of Fluid, on which the Influence of Nerves ſeems to depend, may be ſupplied to the Muſcles there, which are obliged to perform ſo frequent and violent Contractions. The Size of the Nerves of the inferior Extremities ſeems larger proportionally than in the ſuperior Extremities; the inferior Extremities having the Weight of the whole Body to ſuſtain, and that frequently at a great Diſadvantage. What the Effect is of the Nerves here being leſed, we ſee daily, when People happen by ſitting wrong to compreſs the ſciatic Nerve, they are incapable for ſome time after to ſupport themſelves on the affected Extremity; and this is ſtill more remakable in the *Sciatic* or *Hip-Gout*, in which the Member is not only weakned, but gradually ſhrivels and waſtes.

THE Syſtole and Diaſtole OF THE HEART,

And the Reciprocal Actions of its AURICLES and VENTRICLES ACCOUNTED FOR.

THAT the Account I am to give of the alternate Motions of the Heart may be rightly underſtood, it will be neceſſary to mention the few following Propoſitions on which it depends.

1. All Muſcles are furniſhed with Blood-veſſels and Nerves, and their Action depends on the Influx of Blood, and of the nervous Fluid into their muſcular Fibres; therefore whenever Muſcles are deprived of a ſufficient Quantity of either one or other of theſe Li-

quors or of both, their Action is weakned or ceaſes. The Truth of this has been fully proved by the Experiments of compreſſing, tying and cutting the Nerves or Arteries of Muſcles.

2. All Muſcles are in a conſtant State of Action as long as Blood and nervous Fluid are freely ſupplied to them. This ſeems evident from the continued Contraction of the Sphincters of the Bladder and *Anus*, and of Muſcles, whoſe Antagoniſts are cut aſunder or become paralytic.

Tho' in theſe two Propoſitions, I have aſſumed a Fluid of the Nerves, for the Probability of which, ſee the Arguments in the foregoing Treatiſe, yet to avoid a Diſpute, it may be here remarked, that the following Account of the Heart's Motions, will equally hold good, by ſuppoſing the Nerves to be ſolid Cords acting by Elaſticity, Vibration, *&c.* if it is only granted, that their Action is neceſſary to the Contraction of Muſcles, and that Compreſſion is capable to hinder that Action, which Experiments plainly ſhew it is.

3. The Nerves of the Heart paſs to it between the two Auricles or two Arteries, and between the Auricles and Arteries.

4. The *Coronary* Arteries, which are the only ones that ſupply the Heart, riſe from the *Aorta* immediately above the middle looſe Part of the ſemilunar Valves, in the ſame Height of the *Aorta* as where the Angles of theſe Valves are fixed.

5. The Edges of the ſemilunar Valves are duplicated with a muſcular Corpuſcle in the Middle, and muſcular Cords running oblique-

ly from that Corpuſcle to the Inſertion of the Valves into the *Aorta.*

Theſe three laſt Propoſitions are evidently made appear to be true by Diſſections.

6. Before the Veſſels in which the Circulation is performed can act, it is neceſſary to ſuppoſe them full of their Liquors, otherwiſe the whole Vaſcular Syſtem could not be all at once put into Action, and the Motion of the Fluids ſent out from the Heart, could not be propagated to that in the returning Veſſels; conſequently the Circulation would be ſtopped almoſt as ſoon as begun.

If then both Auricles and Ventricles attempt, upon the firſt Communication of Motion, to contract; the Ventricles being ſtronger will force their own Contraction, and hinder the Contraction of the Auricles, which muſt be in the mean time much dilated by the Influx of Blood from the Veins (Prop. 6.) and at this Time, the Arteries are alſo diſtended by the Blood thrown out of the Ventricles; therefore the Cardiac Nerves lying between them, (Prop. 3.) will be compreſſed and prevented from exerting their Office. While this happens to the Nerves, the Blood ruſhing out of the left Ventricle into the *Aorta*, and thruſting the ſemilunar Valves outwards and upwards, diſtends the great Artery conſiderably, whereby the Valves are ſtretched, and their lunated Edges are brought to be ſtraight and as high as their Angles; conſequently theſe Edges, thus raiſed and preſſed to the Sides of the *Aorta*, are made to cover the Orifices of the *Arteriæ coronariæ*, which the Corpuſcles will aſſiſt to do more adequately; and therefore, while they are in this Situation, no Blood can be ſent to the Subſtance of the Heart. If then the Nerves do not exert their Office, and Acceſs is denied to the Blood, this Muſcle, the Heart muſt (by Prop. 1.) become paralytic or unactive.

The Auricles, which were attempting all this Time to contract themſelves, will now, when the Reſiſtance to them is removed, throw the Blood they contain into the Ventricles; and the Arteries that were violently diſtended while the Ventricles puſhed the Blood into them, will at this ſame Time when the Ventricles ceaſe to act, conſtrict themſelves; and the *Valvulæ ſemilunares* will, by their Elaſticity aſſiſted by the muſcular Corpuſcles and Cords, be depreſſed inwards. Since then, by the Conſtriction of the Auricles and Arteries, the Nerves of the Ventricles are freed from the Compreſſion they ſuffered while the Auricles and Arteries were diſtended; and ſince the Blood in the *Aorta* preſſed ſtrongly by the contracting Sides of this Artery, and reſiſted by the Liquors which are to be thrown through all its Branches, is alſo puſhed with great Force on the Orifice of the left Ventricle, thruſts back the ſemilunar Valves which ſtop its Entry into that Cavity, and impetuouſly ruſhes into the coronary Arteries: Since then, I ſay, the Nerves of the Heart are again free from Compreſſion, and the Blood is again ſent to the Heart by its Arteries, its muſcular Fibres muſt again contract (by Prop. 2.) And thus, as long as theſe Cauſes continue to act and ceaſe alternately, their Effects muſt be exerted in the ſame

Manner;

Manner; that is, as long as an Animal lives, the Heart muſt have an alternate State of Contraction called its *Syſtole*, and of Relaxation or *Diaſtole*; and the Auricles and Arteries muſt be dilated, while the Ventricles are contracting, and the Ventricles muſt be dilated while the Auricles and Arteries are conſtricted, or their Actions muſt always be reciprocal.

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THE DESCRIPTION

Of the Human

Lacteal Sac and *Duct*.

THE *Receptaculum Chyli* of *Pecquet*, or *Saccus lacteus* of *Van Horne*, is a membranous ſomewhat pyriform Bag, two Thirds of an Inch long, one Third of an Inch over in its largeſt Part when collaſped; ſituated on the firſt *Vertebra* of the Loins to the Right of the Aorta, a little higher than the right emulgent Artery, behind the right inferior Muſcle of the Diaphragm; it is formed by the Union of three Tubes, one from under the Aorta, the ſecond from the Interſtice of the Aorta and Cava, the third from under the Emulgents of the right Side. The *Lacteal Sac*, becoming gradually ſmaller towards its ſuperior Part, is contracted into a ſlender membranous Pipe, of about a Line Diameter, which is generally named, The *THORACIC DUCT*. This paſſes betwixt the muſcular *Appendices* or inferior Muſcles of the Diaphragm, on the Right of, and ſomewhat behind the Aorta; then, being lodged in the cellular Subſtance behind the *Pleura*, it mounts between this Artery and the *Vena azygos* as far as the fifth *Vertebra* of the Thorax, where it is hid by the *azygos* as this Vein riſes forwards to join the deſcending or ſuperior *Cava*, after which the Duct paſſes obliquely over to the left Side behind the *OEſophagus*, *Aorta deſcendens*, and great Curvature of the Aorta until it reaches the left carotid Artery; behind which, and on the left Side of the *OEſophagus* it runs to the Interſtice of the firſt and ſecond *Vertebra* of the Thorax, where it begins to ſeparate from the carotid, ſtretching farther towards the left internal Jugular Vein by a circular Turn, whoſe convex Part is uppermoſt. At the Top of this Arch it ſplits into two for a Line and a half, the ſuperior Branch receiving into it a large lymphatic Veſſel from the cervical Glands. This Lymphatic appears, by blowing Air and injecting Liquors into it, to have no Valves; when the two Branches are again united, the Duct continues its Courſe towards the internal Jugular Vein, behind which it deſcends, and immediately at the left Side of the Inſertion of this Vein enters the ſuperior poſterior Part of the left ſubclavian Vein, whoſe internal Membrane duplicated forms a ſemilunar Valve that is convex externally, and covers two Thirds of the Orifice of the Duct; immediately below this Orifice a cervical Vein from the *Muſculi ſcaleni* enters the ſubclavian

The Coats of the *Sac* and *Duct* are thin tranſparent Membranes; from the In-ſide of which, in the Duct, ſmall ſemilunar Valves are produced, moſt commonly in Pairs; which are ſo ſituated, as to allow the Paſſage of Liquors upwards, but oppoſe their Return in an oppoſite Courſe. The Number of theſe is generally ten or twelve.

This is the moſt ſimple and common Courſe, Situation and Structure of the *Receptaculum chyli* and *thoracic Duct*; but having had Occaſion to obſerve a Variety in theſe Parts of different Subjects, I ſhall ſet down the moſt remarkable of them.

The Sac is ſometimes ſituated lower down than in the former Deſcription, is not always of the ſame Dimenſions, is not compoſed of the ſame Number of Ducts, and frequently appears divided into ſeveral ſmall Cells, inſtead of being one ſimple Cavity.

The Diameter of the Duct is various in moſt Bodies, and is ſeldom uniform in the ſame Subject; but frequently ſudden Enlargements or *Sacculi* of it are obſervable. The Diviſions which Authors mention of this Duct are very uncertain. I have ſeen it divided, and one Branch climb over the anterior Part of the *Aorta* at the eighth *Vertebra* of the *Thorax*, and at the fifth ſlip behind that Artery, to join the other Branch which continued in the ordinary Courſe. The preciſe *Vertebra*, where it begins to turn to the left Side, is alſo uncertain. Frequently it does not ſplit at its ſuperior Arch; in which Caſe a large Sac is found near its Aperture into the ſubclavian Vein. Generally it has but one Orifice; tho' I have ſeen two in one Body, and three in another: Nay ſometimes it divides into two, under the Curvature of the great Artery; one goes to the right, another to the left ſubclavian Vein; and I have found this Duct diſcharging itſelf entirely into the right ſubclavian. The lymphatic Veſſel which enters its ſuperior Arch is often ſent from the *thyroid* Gland.

Whether is not the Situation of the *Receptaculum chyli* ſo much nearer the muſcular *Appendices* of the Diaphragm in Men than Brutes, deſigned to ſupply the diſadvantageous Courſe the Chyle muſt otherwiſe have in our erect Poſture?

Does not the Deſcent of the Extremity of the Duct to the ſubclavian Vein, and the opening of the lymphatic into the Top of the Arch, contribute to the ready Admiſſion of the Chyle into that Vein?

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